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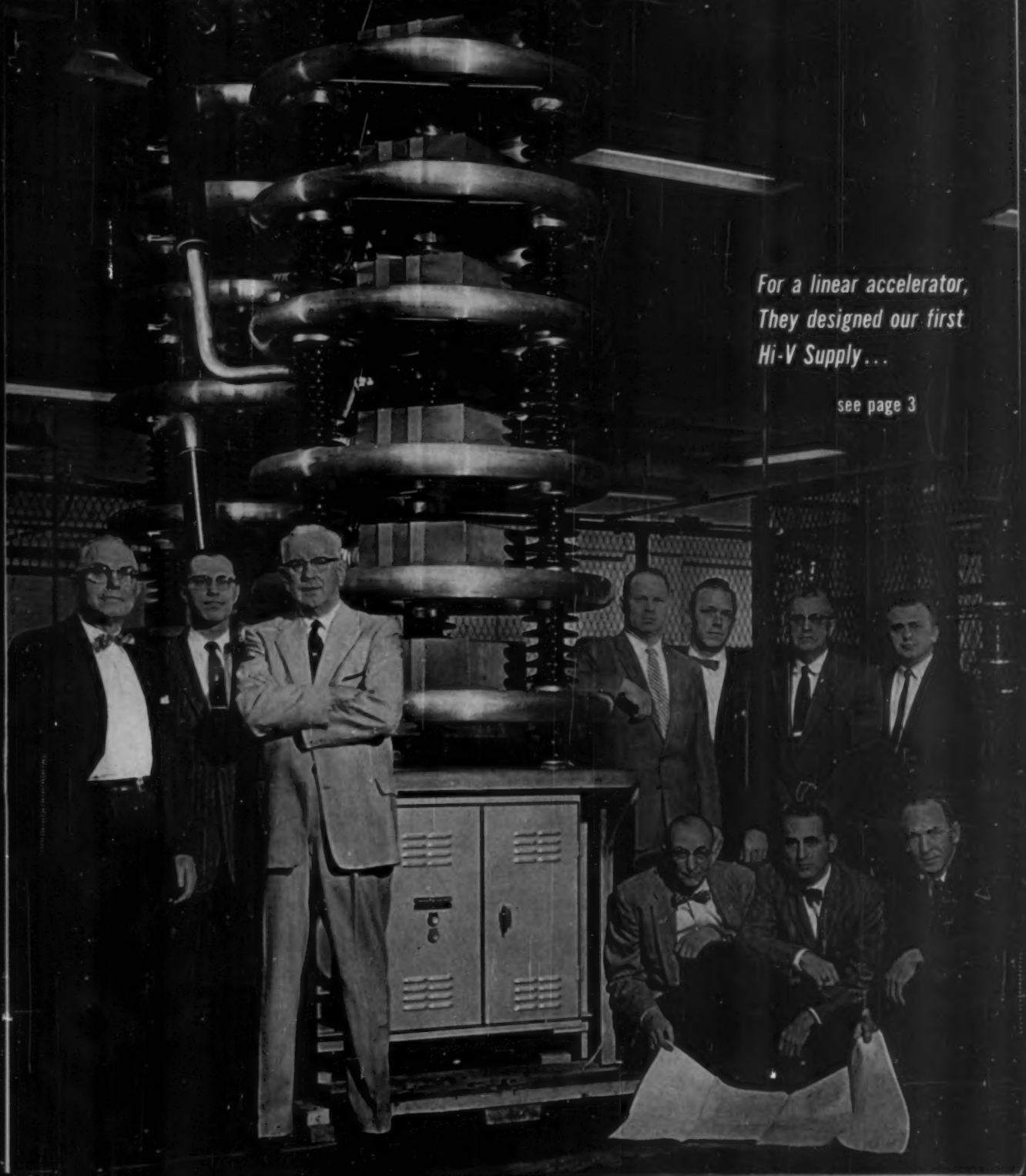
PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT · JUNE 20, 1960



For a linear accelerator, They designed our first Hi-V Supply...

see page 3

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THE ORIGINAL ABS RESIN

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Your move to **KRALASTIC**

KRALASTIC is the original ABS rubber-resin plastic. It is rust-proof, immune to corrosion.

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PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

June 20, 1960 Vol. 31, No. 25

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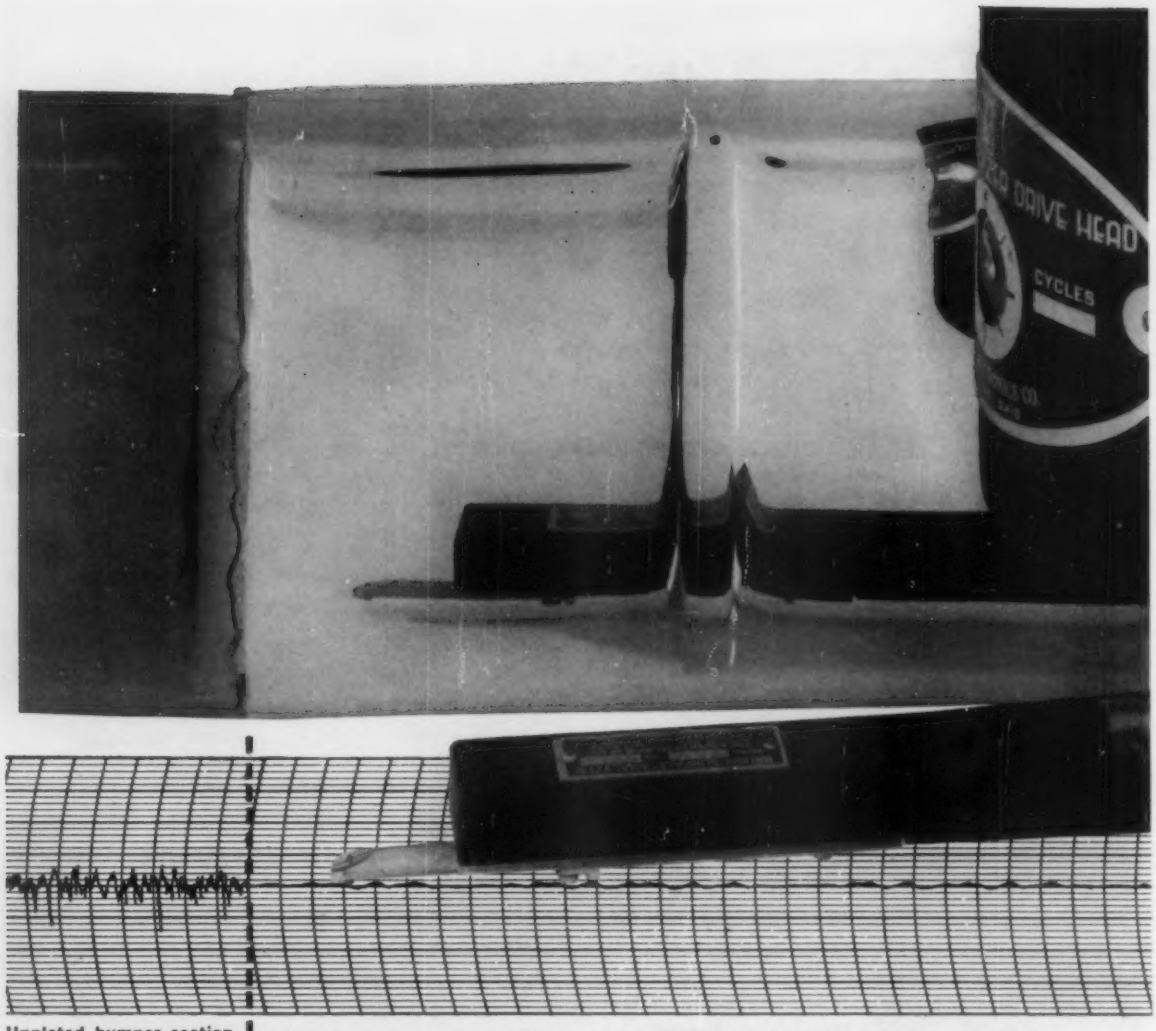

Unplated bumper section shows surface variations averaging 40 micro-inches.

Same bumper section plated with 2 mils of leveling Nickel and 0.01 mils of chrome shows an average variation from level reading of no more than 5 to 6 micro-inches.

See how a layer of leveling Nickel takes polishing-buffing costs out of plating

Above, you see how a layer of leveling Nickel can be used on bare steel to even out surface imperfections, reducing the need for polishing and buffing before and after plating.

The leveling Nickel, however, could have been applied to a zinc, brass or aluminum part or product with equally good results

Special Nickel baths have been developed to coat and smooth the rough surfaces of a wide range of basis metals. By employing these baths, engineers and designers can reduce, in many cases *eliminate* high polishing and buffing costs.

You get higher quality, too. Leveling Nickels, when plated semi-bright, are often coated with bright Nickel before chrome plating. The thick, duplex Nickel coating that results assures high brightness and lasting beauty. It provides a mirror-smooth, white-metal foundation for a brilliant blue-white finish. It backs up the chrome and cushions it against cracking — protects basis metals from rust and corrosion.

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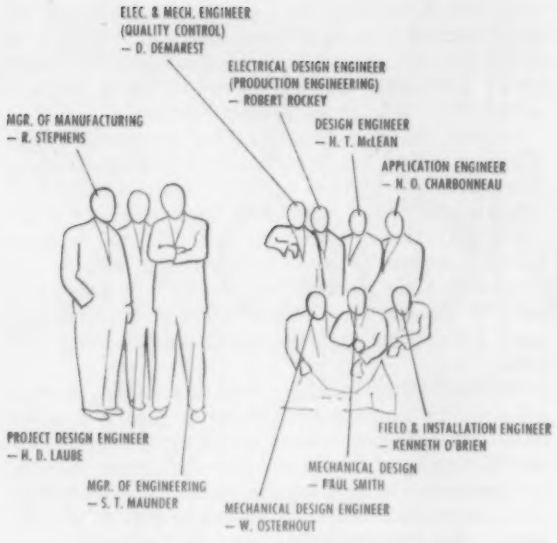
INTERESTING TO NOTE



On our cover—a 4-stage, 600,000-volt Cockroft-Walton power supply to be used in linear acceleration. Power supplies of this type were formerly made in Europe; this one was manufactured by the Hi-Voltage Specialty Transformer Section of General Electric Co in Holyoke, Mass.

The Best Computer of Them All

Although machines with built-in memories are common nowadays (the article on page 68 presents tips on selecting memory devices), science has yet to explain fully how the human brain remembers. The agility of our brain is by far the finest example of a miniaturized, lightweight computing machine ever developed. Some classic feats of mental gymnastics still defy explanation. For example, there is the aprocryphal story of the radio engineer who aproached the late musical great, Arturo Toscanini, asking how long it would take the NBC Symphony Orchestra to play a certain piece of music on the air that evening. "What time is it?" asked Toscanini. "Seventeen past two," the engineer replied. "Then sit and wait," said the maestro as he made phone calls, wrote memos, and scurried in and out of his office. Then, while speaking with an associate, he glanced at the waiting engineer and said, "What time is it now?" "Quarter to three, sir," replied the engineer. "Then I will play the symphony tonight in 28 minutes," Toscanini announced.

Mentally conducting a musical score while being occupied with several other things is a rare test for the human brain. However, there are even greater feats of human memory. In the book *Mathematical Recreations and Essays* by W. W. R. Ball, some fascinating mental computations are attributed to William Klein of the Mathematisch Centrum, Amsterdam. Not only has Klein memorized the multiplication table up to 100 x 100 and all squares up to 1000 x 1000, but he also knows by heart

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the logarithms of all numbers less than 100, and all prime numbers less than 10,000 (to 20 decimal places). He has also learned enough about the calendar to be able to give the day of the week corresponding to any specified date in history. (For fun he memorized a good part of the Amsterdam telephone directory.)

A photographic memory is not uncommon but the ability to mentally apply lists of facts is. Mr Klein is able to multiply a pair of 6-digit numbers faster in his head than an ordinary man can use a desk calculator. He once multiplied 1,388,978,361 by 5,645,418,496 completely in his head, a calculation which involved 25 multiplications, each of 2-digit numbers, and 24 additions of 4-digit numbers—49 operations in 64 seconds.

A Signal Accomplishment

When a surgeon devised a system to help the deaf communicate, the Army became interested. Perhaps the doctor could also devise a system of sign language between military outposts. One hundred years ago, on June 21, the Army surgeon, Maj Albert J. Myer, became Signal Officer of the Army—our Signal Corps was born. Within a year, the country was engaged in a Civil War and Maj Myer's signalmen were quickly put to work. A code system was developed—waving flags by day and torches by night. This semaphore system was an effective means of communication throughout the war.

Maj Myer also had ideas of putting the electric telegraph into the field service of the Army. Civilian telegraphers, directly controlled by Secretary of War Stanton and paid by the Quartermaster, were employed in the military effort of the North. This was the US Military Telegraph, which provided command and administrative communications between major headquarters. But Maj Myer wanted a tactical electric telegraph which could be moved about freely in the field. Working with civilian inventors, he brought about the development of Army's first electrical communication device, the Beardslee magnetoelectric telegraph set. Hand-operated (without batteries) and readily portable, it could signal over several miles of insulated field wire, which soldiers laid rapidly over the ground or strung on lance poles. They called it the "Flying Telegraph."

In 1863, Secretary Stanton had a disagreement with Myer and ordered him to turn all electric telegraph operations over to the Military Telegraph organization. Myer, then a colonel, was transferred to the Department of the Mississippi. However, after the Civil War and Secretary Stanton's departure, the War Department restored Col Myer as the Chief Signal Officer. In 1867, he gained control over the command and operation of all Army telegraph lines—including lines linking isolated camps and posts.

Communications has always been essential for an army, and as Editor Tangerman points out on page 57 it is also essential to engineers. Frank Coss, vice-president of Scientific Technological Communications Inc, made an interesting point at a recent conference sponsored by New York University's Office of Special Services to Business and Industry. Said Coss, "We find ourselves, paradoxically, setting up radio communication with other stars, hoping that intelligent life may be there and anxious to talk with us, and meanwhile we have difficulty learning what the engineer in the next department is working on."

—Benedict A Leerburger Jr

NEXT WEEK IN PRODUCT ENGINEERING

. . . **The Significance of WK^2 and How to Calculate It**
When the load on a motor requires frequent starting, stopping or reversal, size of motor may be dictated by the power needed for acceleration.

. . . **Guide to Ballbearing Slides**
Rundown on basic types, load capacities and best mounting methods.

. . . **Combined Loads on Beams**
A consulting engineer examines "the other axis." Equations provide a useful analytical tool.

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DEVELOPMENTS TO WATCH...

New dielectric material for capacitors, molded parts

A new material offering unusually high dielectric constant and low dissipation factor has been developed by American Cyanamid and is now available for evaluation from its Petrochemicals Dept.

This is a modified cellulose that can be cast into film, molded, or serve as a coating for papers, films, and foils. Basically, it's similar to the cyanoethylated compounds introduced over the past few years for use as transformer papers. But the new material (tradenamed Cyanocel) contains a much higher percentage of nitrogen and no longer has the fibrous form of cellulose.

Many of Cyanocel's properties are still being evaluated and applications have only begun to be explored. But Cyanamid reports the material can be made into thin films (down at least to 0.1 mil) that show good clarity and excellent strength. It can be coated on foils, in thicknesses to 5 mils or more; can be molded into disks, plates, and similar shapes. Among the most promising current possibilities is its use in flexible electroluminescent panels.

At a frequency of 100 cycles, Cyanamid says, the material has a dielectric constant of 13.0 and dissipation factor less than 0.02. Even at 1 mc, its dielectric constant is 10.0; dissipation factor, 0.12.

Unusual metallic compositions made by powder metallurgy

A powder metallurgy technique that reinforces the basic compact in two ways can produce strong, workable combinations of unusual metals, say R. Kieffer and K. Sedlatschek of Metallwerk Plansee, Reutte, Tyrol, West Germany.

The process itself involves insertion of metal wire, mesh or coil in the mold before the powder is added, and then infiltration of the compact with another metal, lower melting than the powder, after the compound has been pressed.

Neither idea is new. But application to such combinations as molybdenum, tantalum and uranium is recent, and there have been a number of improvements in both reinforcing and infiltration methods. For instance, it is now known that the blocking of capillaries and pores which occurs when a readily alloyable metal is used as the infiltrant can largely be overcome by using very-large-particle powders (to 200 microns) for the basic compact, adding auxiliary metals which alloy with both the powder and infiltrant, using flow-promoting fluxes and liquid salts, and keeping infiltration times as short as possible.

With these improved techniques, Kieffer and Seidlatschek have reinforced molybdenum powder with wire coil and then infiltrated it with uranium; and have produced a number of unusual tantalum, titanium, zirconium and molybdenum disilicide and nitride compositions.

British develop 3-cyl flameproof diesel for industrial vehicles

For mine tractors and industrial trucks that operate in hazardous areas, and similar equipment, Perkins Engines Ltd has designed a 3-cyl, 29-bhp, 1650-rpm diesel with a number of special features.

It has a water-jacketed manifold to cool exhaust gases, and is designed for flameproof mounting of exhaust gas conditioner, flame trap, and fuel atomizer. Maximum torque is 98 lb-ft at 1200 rpm; capacity is 153 cu in., compression ratio is 17.4:1. Approximate dimensions: length, from rear of crankshaft flange to fan mounting face on water pump pulley, 23 in.; width, 22½ in.; height, crankshaft centerline to top lifting eye, 22 in.

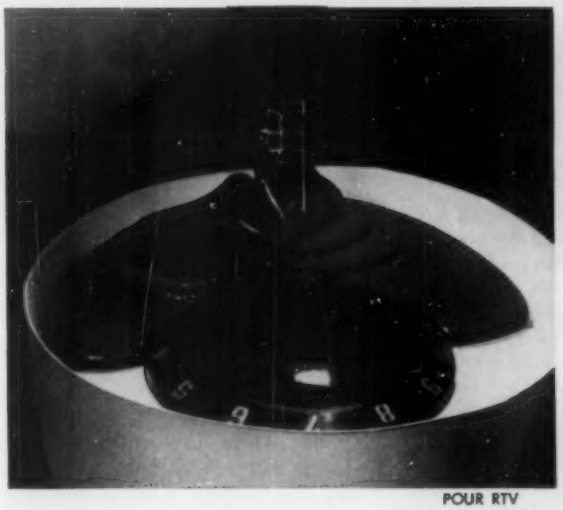
New ceramic readied for electrical and electronic jobs

Boron phosphate-silica compositions show promise for fabrication of electrical insulators with ultralow-loss properties, a Rutgers-Signal Corps research team told the American Ceramic Society.

Rivaling fused silica itself in electrical and mechanical properties, the new material is claimed to be much easier to form and fabricate. It melts at 2300 F (about 600 F lower than fused silica) and can readily be sealed to metal.

SILICONE NEWS from Dow Corning

Quick, Easy, Exact Mock-ups



POUR RTV

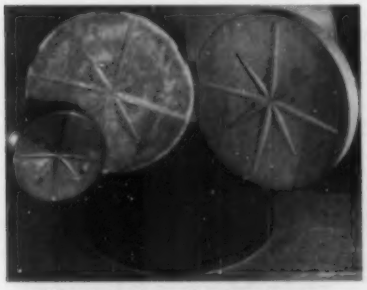
STRIP MOLD

CAST MATERIAL ↓ FINISHED PART ↓

SILASTIC® RTV SILICONE RUBBER makes precision prototype molds

To visualize your product designs quickly, perfectly, and economically, produce models in molds made from Silastic RTV, the Dow Corning silicone rubber that vulcanizes at room temperature. Supplied as a fluid plus catalyst, Silastic RTV is easily poured over any original pattern . . . simple or complex. In a matter of minutes or hours—your choice—the fluid sets up to a firm, flexible rubber . . . *Silicone* rubber, which means it will tolerate hot casting materials up to 500 F without damage. And because the mold is flexible it can be stripped from forms having deep draft angles. The hairline-fine detail reproduced is nothing short of amazing.

Yet the benefits don't end there. Silastic RTV seldom needs a parting agent: in most cases it peels free of other material with ease. When a release agent *is* necessary, a simple solution of household detergent does the job. What's more, you can cast Silastic RTV in a mold of Silastic RTV to produce exactly matching positive and negative molds. One company uses this method to make matching top and bottom embossing dies from a single original pattern. (Shown, left)



This insignia embossing die was sunk from a plastic template made in Silastic RTV mold. Clockwise from left: die, template, wood original, Silastic RTV. Courtesy Cadillac Stamp Co., Detroit.

Molds of Silastic RTV have good durability, and will permit runs of considerable numbers. This ability to produce in quantity means you can test new designs on consumers or dealers throughout the country with minimum investment in tooling and hand-made models. Just mock up your visuals in plastics or low-melting alloys cast in molds of Silastic RTV.

Of course, you'll know better what you can do with this new material when you have samples and data in your own hands . . . Write today.

Free Sample. Write on your letterhead for data and sample of Silastic RTV. Address Dept. 7206

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Deformable metal provides tighter seals

Metals that will create a positive seal by deforming under pressure are finding increasing application in vacuum equipment.

Already in use in this country are several types of expandable steel and crushable indium seals (*PE*—June 6, p 9).

Now, the United Kingdom's Atomic Energy Authority reports a valve system in which a deformable-metal valve-seat washer forms a seal by plastic flow under pressure from a flange on the nose portion of the valve.

Almost any soft metal can be used, including such relatively inexpensive ones as aluminum, copper, and lead as well as the noble metals gold, palladium, and platinum. UKAEA admits these metals may become harder in use; but suggests baking the entire valve to anneal the washer and restore its usefulness. (The indium seals, specifically designed for low-temperature use, take advantage of indium's resistance to hardening.)

Pressure sensor replaces bellows with flexible bladder

A novel high-sensitivity, shock-resistant device for measuring rapid changes in atmospheric pressure, developed at the AEC Los Alamos Laboratory, is now available for nonexclusive, royalty-free licensing.

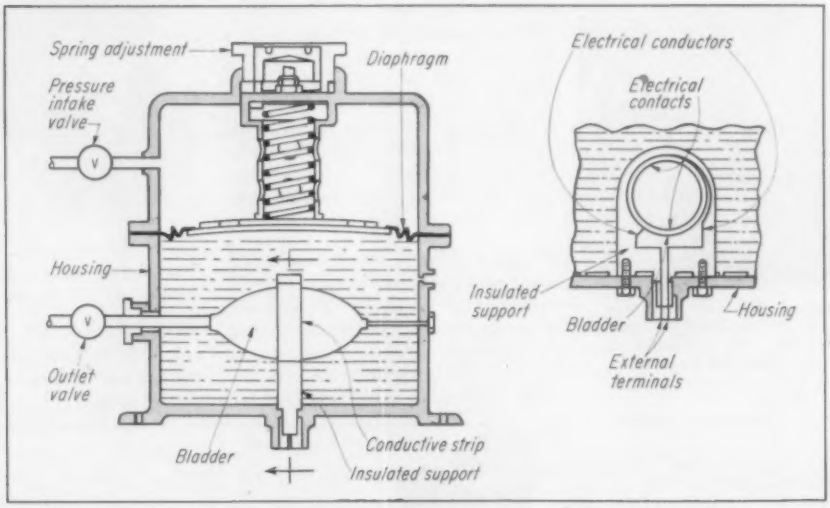
Instead of using the conventional metal bellows, it has a flexible bladder immersed in an incompressible fluid.

The bladder is freely supported in one chamber (see diagram), and is vented to the atmosphere; while the other chamber is held at a preset pressure of an airtight housing. When the atmospheric pressure is equal to or greater than the force exerted by the fluid, the bladder expands, making an electrical connection between two contacts mounted inside its cylindrical supporting member (see cross-section).

A movable metal diaphragm separates the two chambers. Its convoluted portion is made of an alloy such as Elgiloy or Ni-Span-C, so designed that there is no change in spring constant with continuous loading.

The bladder itself may be a flexible plastic on which a conductive strip can be electrodeposited, or it may be made of gold foil. The fluid in which it is immersed may be a silicone or other material chosen for the expected operating temperature range.

The inventor of the device, K. E. Pope, of Los Alamos, says the unit shows a large displacement with a small change in pressure, is not sensitive to noise, operates on a small volume of incoming air. —ARG



PRESSURE-SENSING DEVICE uses expandable bladder to indicate when pressure rises above preset level. Cross-section through bladder's insulated support shows electrical contacts and conductors that connect to external terminals.

WHAT'S HAPPENING IN RESEARCH...

"Metallurgy" of gases under study

Solid gases are under study at U of Virginia. The aim: to locate transition points, develop phase diagrams and examine properties of materials which normally are gases but can be solidified at ultralow temperatures.

First to be selected were solid oxygen, methane, and deuterium-substituted methane. Studies at atmospheric pressure but very low temperature gave surprising results.

Prof J. W. Stewart of UV reports, for instance, that deuterium-substituted ("heavy hydrogen") methane undergoes two transitions at ultralow temperatures (22.1 and 27.2 K); while "normal" methane shows only one (20.5 K). But, in both methanes, the transitions were more conspicuous on the decreasing-pressure side of the hysteresis loop than on the increasing-pressure side.

At 77 K, Stewart notes, solid methane is quite plastic and can be extruded smoothly through a hole in the containment cylinder. At lower temperatures, though it becomes quite brittle.

Solid oxygen, too, is brittle at ultralow temperatures (4 K); but transmits hydostatic pressures at temperatures above 30 K.

Further tests are now underway.

Electronic components may use liquid semiconductors

Liquid semiconductors are under study in both Canada and the US. These are single elements like tellurium and chemical compounds like tin sulfide and indium antimonide in molten form.

In a report prepared for the Chemistry in Canada Conference, D. Boutin and M. Bourgon of the U of Montreal give results of electrical conductivity measurements on tin sulfide at temperatures above its melting point (630 F). They note its conductivity increases regularly with temperature, going from 22.9 ohm^{-1} cm^{-1} at 1650 F to 34.0 ohm^{-1} cm^{-1} at 1720 F. The relatively high value of its conductivity and the positive temperature coefficient would seem to indicate, they say, that tin sulfide, known to be a semiconductor in the solid state, retains these properties in the melt.

At the U of Chicago Institute for the Study of Metals, A. J. Greenfield and H. Fritzche are devising methods for measuring the Hall coefficient of liquid metals and alloys. The factor is so small for most liquid conductors that attempts thus far have not been successful. Among the semiconductors and semimetals, though, they've found several (tellurium, indium antimonide, bismuth, antimony) with large enough coefficients to permit measurements by presently available techniques, and they hope to measure others with new magnetoresistance techniques now being developed.

Shrinking ceramics may pose new problems

Pure oxide ceramics not only shrink during firing, but some also shrink long after firing if put to work at temperatures near their firing range, say Ames Laboratory (Iowa) researchers.

That's one result of a continuing study of magnesium oxide-calcium fluoride refractories at Ames.

Additions of CaF to MgO can be beneficial, the Ames researchers say, in that CaF promotes sintering and increases the density of parts formed at low pressure (by jolt-packing at 890 psi) and of parts formed at higher pressures (by standard compacting techniques at 22,280 psi) but fired at relatively low temperature.

However, in low-pressure compacts, CaF additions seem to increase shrinkage, almost without limit. Parts continue to shrink as long as they are soaked at firing temperature.

In high-pressure compacts, CaF in amounts to 4 mol % (7½% by weight) does increase density without markedly increasing shrinkage; but it is of value only where firing temperatures are relatively low (2500 to 3000 F). When parts can be fired at 3500 F, best results are obtained where no CaF is used at all. Furthermore, if higher percentages of CaF are added to specimens of this type, they tend to become bloated rather than shrink during firing.

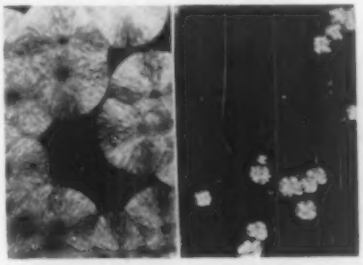
Pinning down polymer melting points

A simple test that measures melting point and rate of crystallization of polymers, and also shows up differences between various polymer types, is described by researchers at Hercules Powder Co.

Crystalline polymers, they point out, appear bright when viewed between crossed prisms and show a characteristic spherulitic structure (photo below, left). This effect is known as birefringence and stems from the fact that light passes through them at different rates in different directions.

When the polymers melt, however, the spherulites disappear, and the light is depolarized, thus providing a precise indication of melting point.

This effect can be observed visually, but the Hercules researchers have come



AS CRYSTALS MELT spherulites disappear, so melting points can be observed in crystalline polymers.

up with an instrumented system that makes the determination simpler and more precise than visual observation.

The equipment consists of a polarized microscope with a hot stage into which a specimen-holding slide can be inserted. A demonstration eyepiece at top of the microscope tube divides the light from the objective; and a photomultiplier tube housing is attached to the side of the eyepiece. Intensity of the light reaching the tube housing is measured by a photomultiplier tube and amplifier, and recorded on a chart.

The Hercules researchers do not claim that the method can substitute for precision dilatometry in measuring rates of crystallization, but they do recommend it where somewhat less refined data are satisfactory. —ARG

For tough expansion problems—

ANACONDA
A-X TUBING

Anaconda A-X tubing is a flexible metal connector with annular corrugations designed to handle the types of movement shown at the right while conveying liquids or gases. It is available in stainless steel and other alloys and is generally sold complete with fittings (right, below). Nominal tubing I.D.'s: 5", 6", 8", 10", 12", 14".

Most axial motion applications involve motion in one direction in respect to the installed position. This may result in compression or extension of the tubing. In a few applications an assembly may be subjected to both extension and compression in relation to the installed length – such cases occur when temperature varies both above and below installation temperature. In order to give the best service for each type of application there are three different corrugation standards for each tubing size:

PRE-COMPRESSED. Designed for extension movement. Will allow a small amount of compression.

STANDARD. Designed for compression movement. Will allow a small amount of extension.

OPEN PITCH. For elbow forming, ducting, or misalignment where little movement is required.

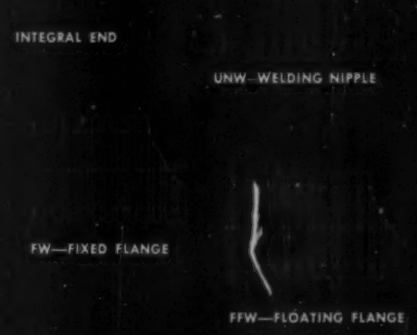
60123

Bulletin A-X 97 gives complete details. Call your Anaconda Metal Hose representative for a copy—or for the services of an Anaconda specialist to help you in the design of a special connector to meet your needs. Or send in coupon below.

BASIC STANDARD UNIT

TYPES OF MOTION

FITTINGS FOR A-X TUBING—UNBRAIDED



FITTINGS FOR A-X TUBING—BRAIDED

ANACONDA® METAL HOSE

Anaconda Metal Hose Division PE
The American Brass Company
Waterbury 20, Conn.

Please send a copy of Bulletin A-X 97

NAME.....

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Cedarapids Super Commander Portable Crushing and Screening Plant, built by Iowa Manufacturing Company, Cedar Rapids, Iowa, produces up to 500 tons per hour of crushed and screened material in four different product sizes.

This high capacity V-Belt Drive handles

60% more power in 30% less space!

Higher Capacity of Gates Super HC V-Belt Drives solves complex product-development problem!

In developing a larger crusher, requiring more horsepower, Iowa Manufacturing Company was faced with the problem of transmitting 400 hp from a higher-speed engine in a space that had been just enough for conventional V-belts carrying 250 hp.

At the higher speeds, centrifugal force made it impossible to go to larger sheave diameters to accommodate larger belt sections. A wider span of belts was ruled out by Highway Department requirements, which restricted overall machine width to eight feet.

Iowa Manufacturing's designers solved their primary problem of transmitting 60% more horsepower with new Gates Super HC V-Belts.

Because Super HC V-Belts have smaller cross section, use narrower and lighter-weight sheaves, pack higher hp capacity in a smaller 'package' than conventional V-belts, designers also succeeded in reducing drive weight, width and height — a decided bonus in equipment that must be moved frequently both on and off the highway.

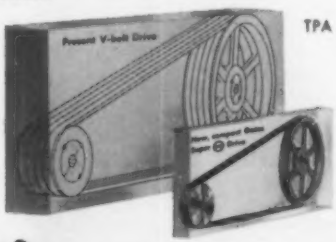
Nation-Wide Engineering Service

Your nearby Gates Representative can show you how to reduce drive weight, space and cost with Super HC V-Belt Drives. With Super HC, sheave diameters can be reduced 30% to 50%, drive space up to 50%, and drive weight 20% or even more.

Ask your Gates Representative for your free copy of "The Modern Way to Design Multiple V-Belt Drives," or write to The Gates Rubber Company Sales Division, Inc., Denver, Colorado.

The Gates Rubber Company, Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario

Gates *World's Largest Maker of V-Belts*



Gates Super HC V-Belt Drives

same hp capacity in smaller "package"

←CIRCLE 10 ON READER SERVICE CARD

CIRCLE 11 ON READER SERVICE CARD 11

FROM WASHINGTON . . .

Industry gripe: NASA doing too much of its own research

Research contractors are complaining to Washington that the National Aeronautics & Space Administration is handling too much of its basic research work in its own labs, and is failing to contract enough to private researchers,

A top official of an important firm told PRODUCT ENGINEERING many private research facilities, geared for astronautic and related activities, will have to diversify into commercial work to keep busy.

He complains the civilian space agency is violating its original intent to farm out the bulk of its fundamental research to contractors—along with hardware development—and is building up its own facilities along the lines of the National Bureau of Standards.

"It's not possible to get a new idea into NASA," this vice-president declares. His views are apparently shared by other industrial contractors familiar with NASA.

R & D contracting on the rise

The Pentagon's rate of R & D contracting is rising. During the April-June 1960 quarter, an average of $463 million worth of contracts per month will be awarded. This compares with $359 million in March.

But the increase does not reflect any post-Summit decision to step up defense spending. The fourth quarter of any Pentagon fiscal year normally shows a higher rate in contract awards than other quarters. And this year, the rate is running higher than usual because of economy measures last fall, which delayed the award of many contracts.

Snag on patent rights

Efforts to switch policy on government patent rights in defense contracts are stalled. The failure of such efforts may generate a special Congressional investigation next year into all facts of the controversial patent issue.

The only pertinent legislation moving through Congress, as this session goes into its final lap, is a bill to restore private patent rights in NASA contracts. This would bring NASA's policy in line with the Defense Dept's—allowing contractors to patent ideas invented on government contract and furnishing the goverment royalty-free use of the patents in return.

The bill has been cleared for a vote in the House. But the outlook is for the Senate to bury the bill even though the House approves.

A Senate Patents Subcommittee, meantime, has studied and reported on the various patent practices of different government agencies. The major study—on the Pentagon—will be finished later this year. But patent problems cut across several Congressional committees—Armed Services, Space, Judiciary, Small Business.

Sen Russell Long (D-La), chairman of the Senate Small Business Subcommittee on Monopoly, wants to adopt for all agencies the Atomic Energy Commission's flat prohibition on patent rights for government contractors.

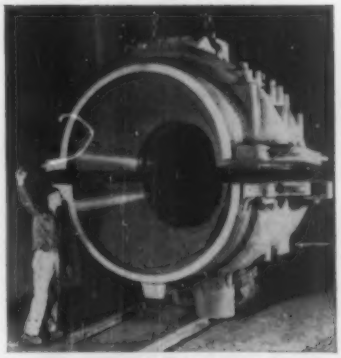
Long argues that patents developed out of defense and other government contracts should be made available to everyone. He claims that big contractors are strengthening their domination of certain industries because of patent rights on military contracts.

Design assistance from Blaw-Knox can cut unnecessary weight, improve the service life of your product

One of the ways in which the skill of experienced Blaw-Knox steel foundrymen can be first applied to your product is in the construction of scale models of the finished steel casting. Coming at the preliminary design stage, scale models permit intensive study of ways of improving quality, eliminating weight, and minimizing machining. This design study, coming before master patterns are made, is conducted to uncover ways in which Blaw-Knox can add to the value of your product or reduce its cost.

This practical design analysis, a feature of Blaw-Knox Steel Casting Service, is of invaluable assistance to designers and manufacturers. And because Blaw-Knox, itself, is one of the world's leading manufacturers of rolling mills and industrial machines, its steel foundrymen, from patternmaker to shipper, keep end-use requirements in mind every step of the way.

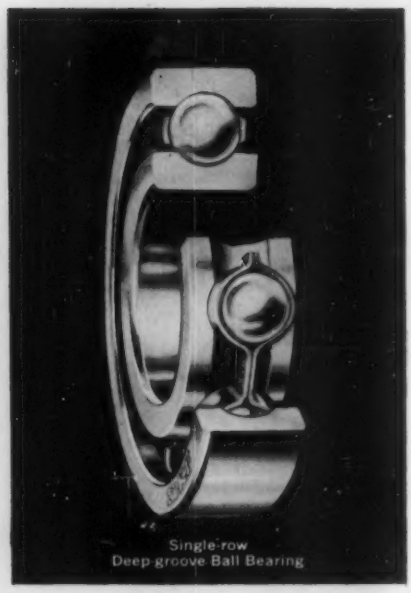
If you are a designer or manufacturer of a product using cast steel components, ranging from 50 pounds to 300,000 pounds, Blaw-Knox would like to send you a copy of our brochure which details the complete Blaw-Knox Steel Casting Service. Write to the Foundry and Mill Machinery Division, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.



This upper and lower cylinder blade ring for a steam turbine was cast and machined by Blaw-Knox. Weight—55,000 pounds per half.

BLAW-KNOX

Steel Castings



Can a standard bearing offer you "more bearing" for your money?

It can if it's made by SKF—because all SKF bearings, both ball and roller, offer special qualities at "production" bearing prices.

Take the single-row deep-groove ball bearing featured here, as an example. SKF designs and builds this type to sustain heavy radial load and thrust load in either direction. Furthermore, it is engineered to run smoothly and quietly at normal speeds with grease lubrication—and at high speeds with oil.

Yet this is a standard SKF ball bearing, mass-produced by automated production equipment at our plant at Altoona, Pa. You can quickly get this bearing in over 100 sizes, ranging from 5/8" to 15.748" O.D., and in a variety of seal, shield and snap-ring combinations.

But why not find out what SKF offers in bearing quality, availability and economy? Just call the SKF branch office nearest you.

6001

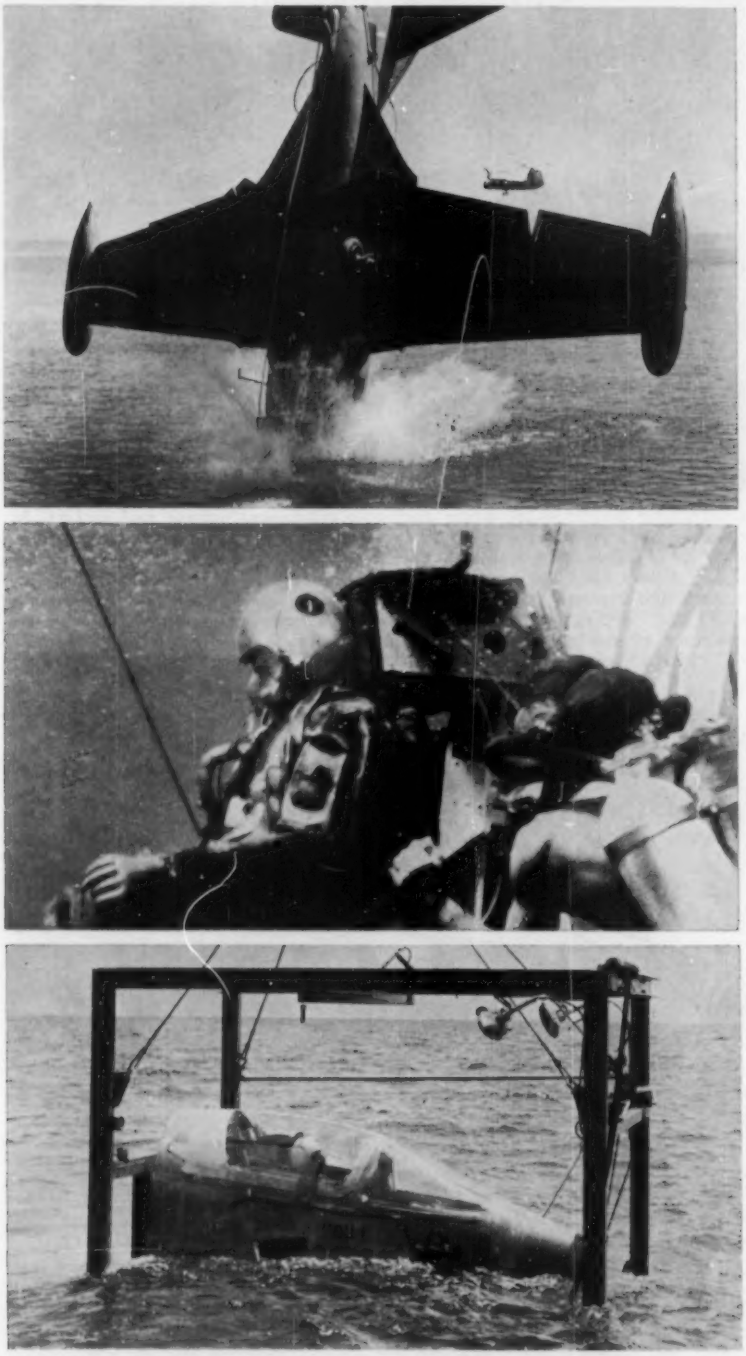
Spherical, Cylindrical, Ball, *Tyson Tapered and RB&D Miniature Bearings

EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

THE ENGINEERING WEEK



VERTICAL NOSEDIVE from 50 ft (top) simulates crash from flight deck of an aircraft carrier, and gives naval aircraft designers information needed to bring more pilots up alive (this plane sank in nose-up vertical position after floating 49 sec). In other tests shown: underwater swimmer checks seat mechanism after ejection test with dummy; cockpit section for F8U-1 aircraft begins underwater descent for tryout of its canopy-remover system.

Destructive Tests Improve Construction of Navy Jets

JOHNSVILLE, PENNA — Destructive testing, a useful tool in missile and aircraft design, is now helping improve design of naval aircraft.

According to T. Claire Bennett, of the Naval Air Development Center here, the Navy has conducted a two-year study of jet aircraft "crashing" in the sea. These crashes have revealed many faults in aircraft design, which can be corrected to save lives of pilots downed at sea.

Johnsville engineers have instrumented obsolete swept-wing and straight-wing craft and shipped them to a crash-test site at Key West, Fla. There, the aircraft are lifted by crane and released from 50 feet above water. Motion pictures, taken by cameras above the surface and underwater, coupled with data from instruments aboard the aircraft have showed surprising results:

- Jet planes sometimes sink up to ten times faster than expected. Sinking rate averages 5 fps, and occasionally reaches 10 fps. Heretofore, the rate was believed to average about 1 fps.
- Jet aircraft submerge with tail down. After first sinking, jets always resurface, regardless of impact force. Built-in buoyancy is responsible for resurfacing.
- At about 20-ft depth, cockpit canopies crush under water pressure and in many cases, the plastic glass ripped into the dummy pilot.
- Seat-ejection systems, which work well in air, very often jam under water.

These test results point up the need for safety devices to get the pilot out fast, and materials and structural designs to slow rate at which plane sinks. Automatic devices for freeing pilots are especially important, Bennett says, because the pilot is generally unconscious or stunned immediately after a crash. A workable underwater seat ejector is now in development. These tests also indicate that a ditched pilot can surface from depths of 100 ft if he has proper equipment. A high-altitude oxygen device, now used by parachutists, can

be modified to serve this function, Navy researchers believe.

Sinking posture of the plane has suggested possibility of better weight distribution on jets; and components to keep planes floating long enough for pilots to escape are under study. The Navy has also issued Mil Specs for a canopy that resists implosion, thereby retarding water leakage into cockpit and rate of sinking.

—John Moore, McGraw-Hill World News Correspondent

Japan's Rocket Symposium a Dud

Tokyo—Japan's second International Symposium on Rockets and Astronautics was a disappointment.

The Russians first had accepted an invitation, then refused to announce the papers they would present, and at the last minute decided not to show up. There was no explanation other that the assumption by the Japanese that the U-2 incident was a contributing cause, since Japan has been a Far East base for the offending aircraft.

The Japanese were also disappointed that H. Wexler, director of the US Weather Bureau's Meteorological Research, did not attend; weather rocketry is a subject close to the heart of the Japanese in the aeronautics field. However, Dr Homer E. Newell Jr, deputy director of the NASA spaceflight program, did attend.

SPACE PROBE NOT DEFINITE

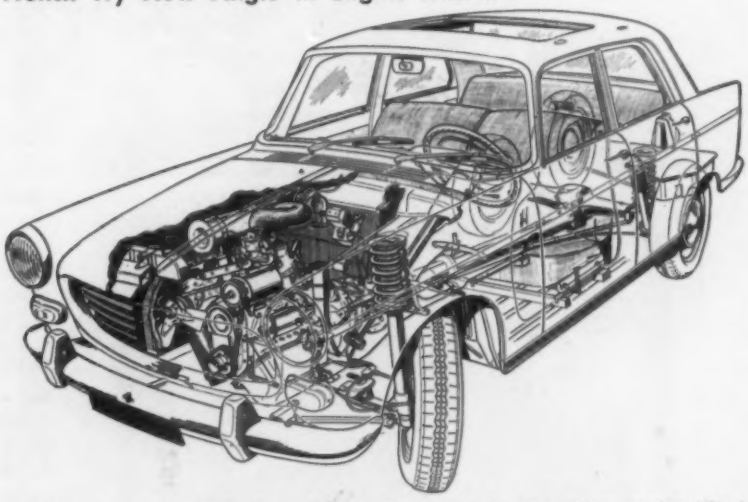
Interest of conferees was centered on a paper on "Resonant Probe for Electron-density Measurement in the Ionosphere," which the Japanese are planning as a cooperative project with NASA. Next year, a group of Japanese scientists will visit Wallops Island, Va, to help launch an NASA Scout satellite with a spherical final stage built by the Japanese. Although no final decision has been made to undertake the project until a number of objections to the proposal have been resolved, the Japanese assume their project is compatible with NASA's offer to cooperate with foreign countries in nonmilitary space projects.

Meanwhile, Japan has officially launched its Council for Space Exploration. The unit will advise the Science & Technology Agency on space research. ■

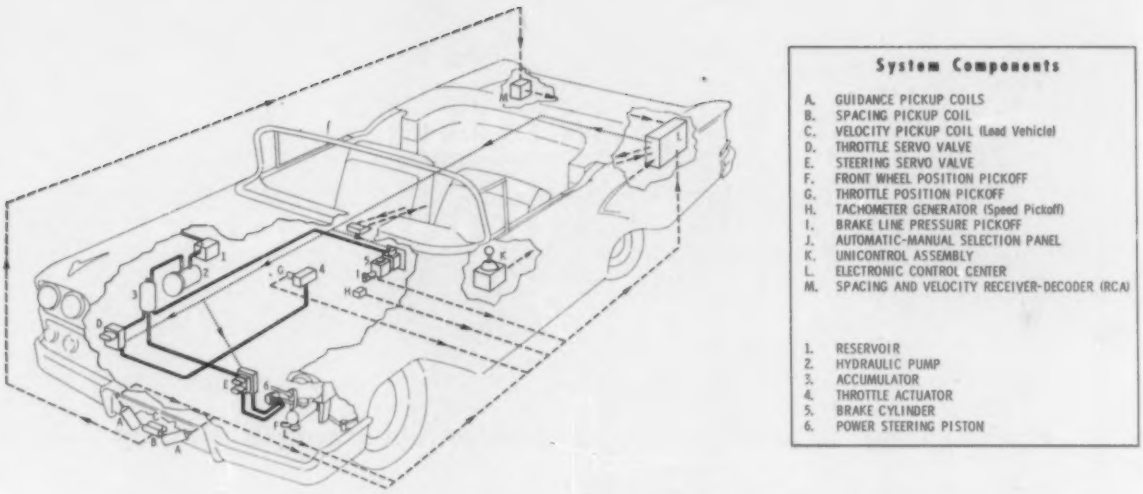
No Brakes, No Shifting Gears Either

Hydrostatic transmission, using positive-displacement pumps and motors, is called newest practical development along this line for heavy-duty vehicles such as road-building equipment, tractors and diesel locomotives. Made by Dowty Group Ltd, England, the "Dowmatic" transmission offers single-lever control, and stepless transmission. It eliminates mechanical line drive, gear shifts and reverse mechanism, and improves maneuverability under difficult conditions. No wheel brakes needed, except for parking. Unit is on display at British Exhibition, NY Coliseum, June 10-26.

French Try New Angle in Engine Mount



This Peugeot 404 sedan is equipped with a 4-cyl, in-line, 72-hp engine tilted on its side at a 45° angle. Advantages: a 2.3-in. lower center of gravity, to hold the road better; improved weight distribution around the car's centerline; lower hoodline, providing better front-seat visibility; open location of motor accessories, for easier servicing. In the front suspension, the shock absorber is mounted inside a long tube that links the stub-axle support to a plate on which the lower end of the suspension coil spring rides. The shock-absorber piston rod and upper end of the spring attach to the body at fender-top height. This geometry cancels out the need for an antiroll bar; in the lower triangle of the suspension, a classic arm braces the weight-carrying arm, which, through a ball-and-socket joint, links the stub-axle support to the body.



Computer-driven car is GM's contribution to the high-speed, yet safe, electronic superhighways of the future.

Where Are Highways Heading? GM and RCA Share Electronic Answer

PRINCETON, NJ—An electronic highway that stops and starts a specially equipped car and guides it around curves within the speed limit was demonstrated by Radio Corporation of America and General Motors here. This was the first full-scale model of a highway concept first tested eight years ago with toy cars in the basement of RCA's David Sarnoff Research Labs.

Though consensus among engineers was that a fully electronic highway, as demonstrated here, is many years away, some elements of the system may have widespread applications soon.

RCA has so designed the electronic circuitry that it can now provide visual warnings to motorists on turnpikes. Later, when autos have the necessary instrumentation, this same circuitry can feed information to the control center of the vehicle, relieving the driver of his usual steering and braking functions.

RCA officials believe electronic highways will evolve gradually from the building-block installations first adopted for safety along hazardous or busy stretches of road. One such experimental installation is now under construction in Nebraska—to govern traffic lights at an intersection. Here, timing of lights is based on density of traffic approaching from four directions. Flexibility of the system is illustrated by the fact that an auto with equipment such as GM showed at Princeton will be able to pass through this intersection—stopping and starting with traffic—without driver intervention.

ELECTRONICS FOR THE HIGHWAY

Electronics for the highway consists of three circuits: one, a detection circuit that senses presence of an auto; the second, a control circuit that puts this signal to work; the third, a guidance cable to keep electronically equipped autos from straying.

The **detection circuit** starts with a wire loop, rectangular in shape, about the size of a car. Buried beneath the pavement, it carries a small ac current which sets up a magnetic field. When a car passes over the wire, the metal of its body causes variations in the field. This variation is picked up by a detecting device buried at side of the road. The loops are spaced sequentially along the roadway.

The **control circuit** is a clearing house for signals from the detectors. Each detection device is teamed with a control element that accepts electric signals from the detectors and passes them into a network connecting all the highway loops.

This signal can be used in a variety of ways. On turnpikes where fog is a problem, the signal can be fed back along the network to light a "flying tail" of warning lights behind the vehicle. These lights can be regulated to indicate the approximate speed of the pace-setting vehicle. The control circuit can also shoot warning signals ahead of a vehicle around blind curves to inform approaching drivers of the car's presence. Likewise, the signals can light signs along the roadway, warning drivers they are exceeding the speed limit; or trip traffic lights at intersections. None of these applications requires special equipment in the car.

If a car does have special electronic sensing equipment, the control circuit sends it information concerning position of cars ahead or behind. The other cars do not need special equipment. By the mere act of passing over the detection loop they feed information into the control system.

The **guidance cable** runs down the center of each traffic lane. Like the detection loop, it generates a steady electric signal, but the frequency is different. This is the signal, of use only to electronically controlled cars, that keeps them on course.

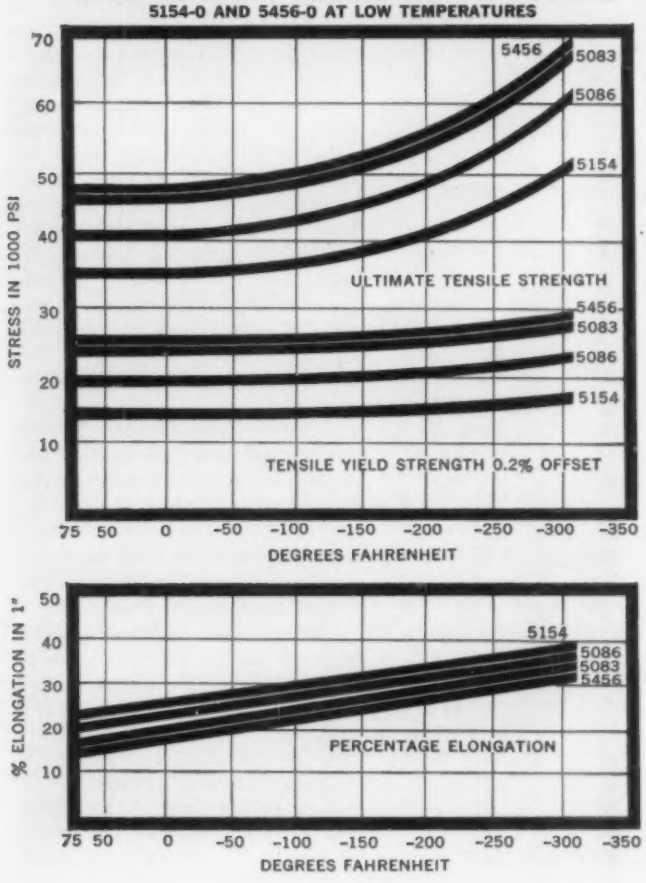
Both of the electronic cars shown by GM were production-line vehicles

continued on page 20

Why Aluminum for Low Temperature Equipment?

- **when temperatures go down, aluminum's strength goes up**
- **aluminum is light in weight**
- **aluminum is easy to fabricate**

TENSILE PROPERTIES OF ALUMINUM ALLOYS 5083-0, 5086-0, 5154-0 AND 5456-0 AT LOW TEMPERATURES



In the strange world of minus 250°F and below, materials often take on new and different properties—a fact which demands special design consideration for low temperature equipment.

And more and more frequently, designers are finding that aluminum, better than any other material, meets the mechanical, thermal and economic requirements for these "cryogenic" jobs.

For example, low carbon steels lose so much impact strength at low temperatures that they can't usually be considered. Nickel-alloy steels have better strength than low carbon steels, but in many cases are more expensive to fabricate than aluminum. Aluminum is one of the lowest-cost metals that retains or improves its impact strength at low temperatures.

LOW TEMPERATURE STRENGTH

Aluminum's properties change at sub-sub-zero temperatures, just as all metals do, but the change is for the better. The yield strength, tensile strength and percentage elongation of aluminum all *improve* as temperatures approach absolute zero. This is not true of all metals: Ferritic steels become brittle at low temperatures; the mechanical properties of stainless steel are improved, but it is costly when compared to aluminum.

INCREASING ALUMINUM USES

Largely because of its excellent low-temperature properties and its low cost, Reynolds Aluminum is used in containers, handling and processing equipment for liquefied gases.

Strong lightweight aluminum sheet, plate, pipe, tubing and extrusions are used to handle and process liquefied natural gases, oxygen, nitrogen, hydrogen, helium, and rare gases. Temperatures required to keep these in a liquid state range as low as −452°F, only 8° above absolute zero! Aluminum is the most economical material that can stand up under these extreme conditions.

In addition to its low temperature strength and ductility, aluminum offers other advantages in containers and handling equipment. It is light in weight—*one-third* the weight of steel—a big benefit in shipping containers and portable equipment.

FABRICATION SAVINGS

Aluminum is easy to handle, easy to join and form. It welds and cuts quickly, often reducing fabricating costs. And it is non-magnetic, non-toxic, and non-sparking, safer to use with volatiles. Finally, *aluminum is one of the lowest-cost corrosion resistant materials available.*

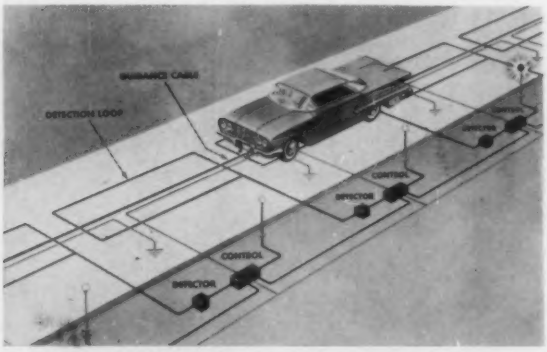
When you design any equipment for low temperature use, be sure to consider the economics and the low temperature strength of aluminum. For full information on aluminum for low-temperature duty, contact your local Reynolds office, or write *Reynolds Metals Company, P.O. Box 2346-HN, Richmond 18, Virginia.*

REYNOLDS ALUMINUM

Watch Reynolds TV Shows: "Bourbon Street Beat" and "Adventures in Paradise"; and, resuming in October, "All Star Golf"—ABC-TV

Ship designed to carry liquefied methane (at −260°F) to England. Liquid is kept in 6,000-barrel tanks made with Reynolds Aluminum plate, the one economical material with improved strength at low temperatures. Aluminum is also used in piping and processing equipment.

Aluminum welds quickly and easily by all common welding methods—as in this liquid gas tank fabrication. It also cuts and forms easily, often effecting savings in construction. And it is one of the most economical corrosion-resistant materials.



SCHEMATIC DRAWING of RCA's electronic highway (left) shows wiring as it is embedded in the road. In this photo, the control circuit is leaving a "flying tail" of lights behind the moving car to warn other vehicles of its presence. The car at right is circling such a roadway at David Saranoff Research Center in Princeton, NJ. The

car automatically follows the circular test course and slows down to avoid collision with the conventional vehicle in the lead. The two instruments on the dash board indicate speed and distance of the car ahead as this information is received from the road by the electronically instrumented car.

continued from page 17

with certain mechanical systems replaced by electro-hydraulic systems. While under automatic control, the vehicles are guided by an analog computer, in the trunk of the car, which receives a steady flow of information from the highway. Output of the computer is the flow of corrective instructions to servomechanisms that control brakes, throttle and steering.

Information from the highway is gathered by pickup coils at front of the vehicle. One set of coils straddles the guidance cable. If the auto veers from left to right, the signal weakens in one of these coils until the wheels turn the car back on course. Another set of coils gathers information on leading and trailing cars to keep the vehicle safely spaced in traffic. On open highways, a tachometer generator compares actual speed of the car with desired speed set manually by the operator, and adjusts brakes or throttle to compensate for hills, wind or other road conditions.

The design of brakes, steering and throttling mechanisms is standard. The hydraulic system that converts electronic signals from the servomechanisms to mechanical action operates from a 1000-psi pump.

The car must be able to operate manually as well as automatically, so GM has installed a control stick to replace the steering wheel. Left or right movement of the stick causes left or right movements of wheels. Foreward or backward movement causes acceleration or breaking. This stick is linked to a potentiometer which actuates the servohydraulic system. There is no mechanical connection between the steering stick and the wheels.

THE PROBLEMS

The major hurdle now, according to Dr Lawrence Hafstad, Director of GM's research labs, is to achieve a high degree of reliability. The system has proved itself on tests with full-scale equipment, and all electronic components are readily available.

Officials from both RCA and GM emphasize that the electronic highway will not completely replace the driver. The sensing equipment does not detect nonmetal objects such as fallen trees or stray animals. Hence, the driver must still watch the road.

RCA officials estimate that highway circuitry will add roughly 10% to present road-construction costs. The increase will be partly offset by doubled car-carrying capacity of the automated highways. The electronic wiring can be installed on existing roads, without tearing them up, by the rapid diamond-saw technique. ■

Sprayed Coating Saves Metal from Heat-treat Losses

DALLAS—Rejection of many close-tolerance parts because of metal loss during stress relieving may be avoided by a method developed by Chance Vought's Aeronautics Div. The technique calls for precoating metals with a copper or aluminum spray to prevent oxidation and loss of material.

Chance Vought engineers say many parts were rejected previously because from 0.002 to 0.012 in. of metal was lost during the thermal treatment. With application of the new precoat, this loss is kept down to between 0.0001 and 0.005 in.

Copper or aluminum spray produces an oxide coat which protects the metal part from damage during hot forming, stress relieving, heat treating or annealing. The precoat forms a lubricant for later forming, stops oxidation, is easily removed after treatment.

Used successfully with various ferric materials and ferrous alloys, the process is said to protect exotic metals such as beryllium, columbium, molybdenum, rhenium, tantalum, tungsten, vanadium, and zirconium, as well as nickel alloys. In fact, the coating is applicable to any metal with which aluminum or copper is non-alloyable.

Max temperature to which metal parts may be thermal-treated is controlled by melting temperature of the coating material—3722 F for aluminum oxide and 2255 F for copper oxide.

Tests prove that the aluminum metal spray protects steel and stainless brazing-retort envelopes and bodies from oxidation at elevated temperatures up to 2000 F. Previously the retorts had to be cleaned of heat scale by sand blasting and vapor honing after each brazing cycle.

—Marvin Reid, Dallas News Bureau

Japan Moves to Switch Its Students into Engineering

TOKYO—One of Japan's leading electrical engineering firms, Hitachi Ltd, has endowed Tokyo Univ with $600,000 to set up an electrical engineering department. This is an attempt—the first—by a Japanese company to diminish the strong trend toward liberal arts. Despite the Ministry of Education's five-year training program, which seeks 8000 engineers by 1962, only 2200 of all graduates this year are in technology.

Hitachi's gift is to a private liberal arts college with an enrollment of 5000 in literature, economics, law and social science. The company hopes to convert some of these students to engineering because Japan suffers from an acute shortage of engineers, especially in the fields of electrical and mechanical engineering, and industrial chemistry. As its part of the bargain, the university hopes to create departments of mechanical engineering and industrial chemistry as well as the electrical engineering department by the next academic year, April 1961. It has already bought an 82-acre site about 40 miles northwest of Tokyo, with ground-breaking slated soon.

The government, too, is worried over the small number of students entering technical fields, and has upped its 1960 fiscal budget by $11 million over 1959 as a fund for the promotion of technology. The general feeling by industrial leaders is that this is but a drop in the bucket. ■

. . . And US Helps Too

TOKYO—Japan's Ministry of Education has accepted $30,000 worth of scholarships offered by RCA to help Japanese science students study in the US during 1960, and also to help promote science education in Japan's schools from primary grades up to university level.

RCA representatives here say the scholarship offers are modest because "We Americans don't want to show off. We only want to express appreciation for our 40-year Japanese affiliation."

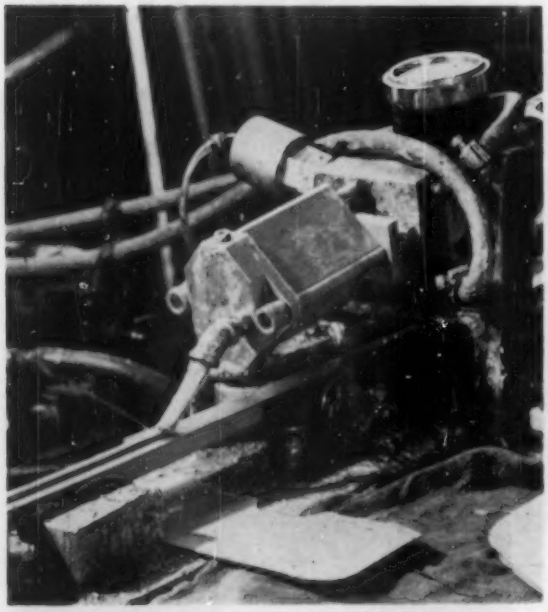
Out of the $30,000 total this year, $12,500 will go to five university graduate students to study in the US. This sum is in addition to what they get under the Fulbright Exchange Student Program. Another $10,000 goes to 80 college juniors and seniors studying science and technology. They were selected from 14 state and private universities. Some $5500 will be given to about 10 grade schools to buy necessary Japanese science books and apparatus. RCA here says that what is left can be spent as the Ministry of Education desires. ■

R & D Spending Rose in 1958, NSF Reports

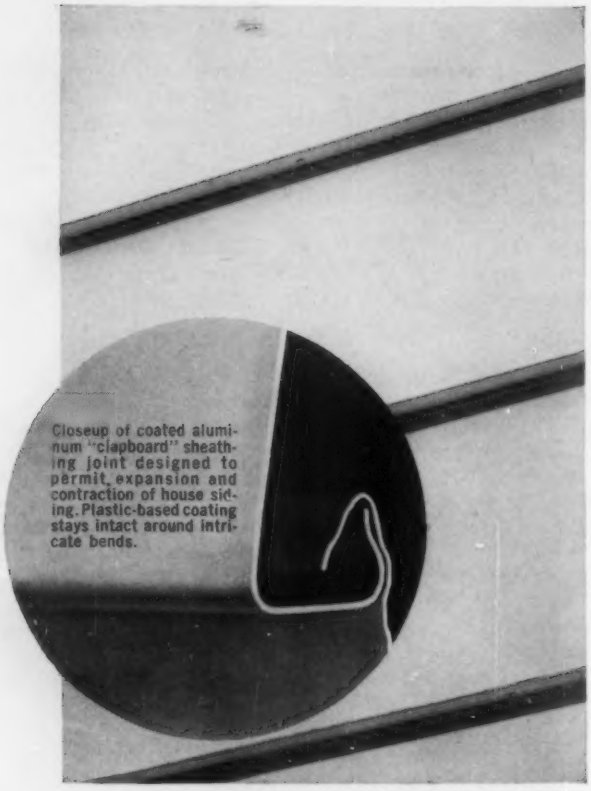
WASHINGTON—Funds allotted to basic research rose 4% between 1957 and 1958 according to a survey by the National Science Foundation. Of the $296 million worth of basic studies carried out in industry, $63 million was spent by industrial chemical firms, $57 million by the electrical-equipment and communication industry, and $43 million by petroleum mining and extracting companies. Machinery industries spent about $21 million, or 7% of the total.

The survey also showed that total R & D in the US amounted to $8.2 million in 1958. Of this, $4.6 million was done on contract for the Federal Government. ■

Glue for the Roof of a Trailer Truck



Fruehauf Trailer Co is now making roofs of its Volume Vans by bonding Z-channel crossbows to aluminum sheet with a polysulfide cement. This procedure is much simpler than welding the customary I-beams and yields faster production of lighter-weight vans. Photo at left shows the polysulfide bond (based on Thiokol's Liquid polymer) being applied to Z-channels. The channels are then placed on a jig (right) where a sheet of aluminum is rolled across them. The aluminum is stretched and heat is applied to cure the compound. A sheet after curing is shown above the jig. In fabricating the body of the van, this roof panel is fastened to the side walls by a stiching machine.



Closeup of coated aluminum "clapboard" sheathing joint designed to permit expansion and contraction of house siding. Plastic-based coating stays intact around intricate bends.

OUTDOORS—A DURABLE VINYL-BASED PAINT TO PRE-COAT HOUSE SIDING BEFORE FORMING

Baked onto the metal before forming, vinyl-based coatings stand up under the strain of shaping and years of service as well. On house siding, weather resistance is a big factor, and the adjoining photograph shows how the aluminum clapboard on a Milwaukee home looked after nine years without refinishing. The coating is still intact.

Shakes as well as clapboards are being formed from this pre-coated metal. On both types, the vinyl-based finish holds fast, with no cracking, chipping, or peeling during shaping, assembly and service. Both primer and topcoat can be applied by roller, brush, or spray. Baking turns the topcoat into a tough, flexible, weather-resistant finish that looks good as new for years with only an occasional washing.

One company pre-coats and bakes the finish on aluminum sheathing which is then formed over an insulation board made of wood fibers, asphalt-treated for weather and water resistance. Another manufacturer designed a special interlocking joint (closeup) that permits expansion and contraction with temperature changes to prevent buckling. What vinyl-based coatings are doing for building materials, they will do for many other products that can be made from pre-coated metal sheets formed at a saving.

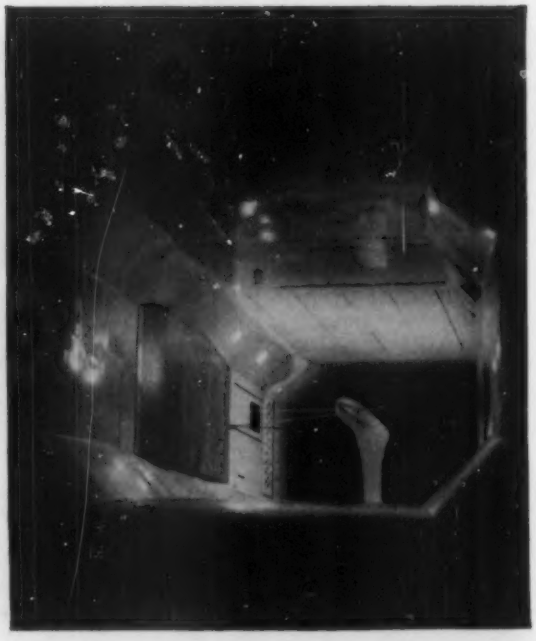
LET PLASTIC-BASED COATINGS

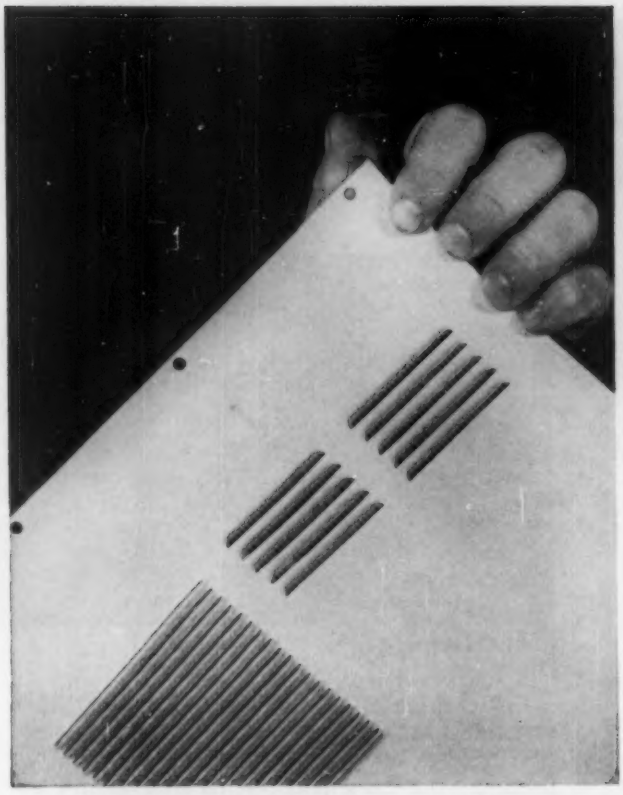
ARTIFICIAL WINDSTORM—OTHER COATINGS BLEW AWAY, BUT PHENOLICS STUCK TO THIS WIND TUNNEL

Before phenolic-based coatings were tried, the paint inside this 8-foot transonic wind tunnel would literally blow off the surface. Nuts and bolts occasionally loosened from models struck the sides and scored the paint. Ordinary paints didn't last long under these conditions.

But a coating based on BAKELITE Brand phenolics was still adhering firmly, in good shape, after two years. Along with extreme durability, its smooth glossy surface demonstrated far greater freedom from friction and resistance to scoring.

Plastics have brought a new set of performance standards to the coatings field. They fit into the new service-environments your designs have to meet, and deserve thorough investigation when you're planning a new approach.





INDOORS—A TOUGH, HARD-WORKING FINISH THAT DRESSES UP ADMIRAL'S PORTABLE TV

Many portable TV cabinets are metal, but Admiral's has a big plus—a simulated morocco leather finish baked on before forming. It's based on BAKELITE Brand vinyl dispersion resins, .012 in. thick, applied to the flat .032 in. steel sheet. Inside, there's another coating of clear vinyl to prevent rust.

The steel sheets are handled and stacked without special treatment, yet the finish is unharmed. They are shaped on the same presses and dies used for unfinished metal, at 250 tons pressure. And even 180 deg. bends do not harm the coating.

The savings with pre-coating have enabled Admiral to offer this de-luxe morocco-leather effect at their standard retail price. Keep vinyls in mind when sturdy housings and other products have to be formed and finished with speed and economy.

◀ **Closeup shows louvers cut and formed into steel sheet pre-coated with dispersion coating based on BAKELITE Brand vinyl resin. Notice that the coating is undamaged, preserving its grainy morocco leather effect.**

HELP YOUR DESIGNS IN METAL

Some of your unusual ideas may work best in metal with plastic-based coatings applied before or after forming. Here are three typical examples:

PLASTIC-BASED COATINGS have helped metals meet new requirements. With their special and unusual properties, plastics have helped bring more freedom to designers, increased product attractiveness, improved performance, and reduced costs. This is true in a variety of product fields beside coatings—molded, laminated, and extruded plastics also provide a host of new directions for your ideas to take. Learn about BAKELITE Brand polyethylenes, epoxies, phenolics, styrenes, and vinyls and their use in design. Their properties are listed in Sweet's Product Design File, section $\frac{2a.}{ui}$

For specific information on how plastics can help with your design problems, mail the coupon today.

"Bakelite" and "Union Carbide" are registered trade marks of Union Carbide Corporation.

UNION CARBIDE

Dept. BO-113, Union Carbide Plastics Co.
Division of Union Carbide Corporation
30 East 42nd Street, New York 17, N. Y.

Please send me information on coatings for metals.
Please send me general information on BAKELITE Brand plastics for design.
The type of application being considered is _____

NAME _____

FIRM NAME _____

STREET _____

CITY _____ ZONE _____ STATE _____

POINTS OF VIEW

A Conversation With a

Like Aristotle, R. Buckminster Fuller can be called a "seeker of things above and below the earth." His seeking has led him to new forms of mathematics and, through these, to an intimate study of man's environment. His method, in part, is conversation: pedantic and prolix, didactic and discursive—but aways spiraling inward to the question before him. When the center is reached, he pauses: "Now . . . to answer your question . . ."

To our regret, we have space only for a truncated version of a stimulating three hours with this fascinating man. Still, his conversation is much like his basic building block, the tetrahedron: cut it away parallel to any surface and the essential structure remains.

According to Fuller's biographer, Robert W. Marks (*The Dymaxion World of Buckminster Fuller*, reviewed on p. 112), comprehensive design "is more a philosophy than a form of engineering." In 1927, Fuller invented the Dymaxion house (coined from "dynamic" and "maximum" to signify the maximum advantage from minimum energy output), which was suspended from a central mast and could be purchased for the price of a '27 Ford. In 1932, the Dymaxion Corp was founded by Fuller to produce and market his inventions. One of these was the Dymaxion Car, a three-wheeled auto that could attain 120 miles per hour,

drive 40 miles on a gallon of gas, cross open country like a jeep, and turn in its own length. But commercial sponsors were lacking and Dymaxion Corp folded in 1935.

One of Fuller's latest developments, the geodesic dome, utilizes a lattice work of tetrahedrons. Pressure applied to any part of a dome's surface is absorbed by the compression and tension struts of the adjacent tetrahedrons. Commercial acceptance of the geodesic dome came in 1953—when Ford engineers were puzzling how to put a conventional dome over the Ford Rotunda Building in Dearborn, Mich. Fuller was called in, made the necessary calculations on the back of an envelope, and constructed the dome in about five weeks at a fraction of what Ford engineers had estimated it would cost. Now radomes designed by Fuller dot the Arctic Distant Early Warning Line and the US Marine Corps has cited Fuller for providing "the first basic improvement in mobile military shelter in 2600 years." Fuller's 200-ft "Golden Dome" of anodized aluminum housed the American Exhibit in Moscow and was sold to the Soviet government after the exposition closed. —BAL

FULLER and his "Golden Dome"—Moscow

"Buckminster Fuller—you are the most sensible man in New York, truly sensitive. Nature gave you antennae, long-range finders you have learned to use. I find almost all your prognosticating nearly right—much of it dead right, and I love you for the way you prognosticate." These were the words of the late Frank Lloyd Wright. Fuller has made some interesting architectural predictions, but when interviewed by a panel of Product Engineering editors several weeks ago, he objected to being labeled "architect." He went on:

I like to be considered an individual first. If, as an individual, I happen to develop a concept or a tangible product in the field of engineering or architecture or perhaps cartography, this doesn't mean I should be labeled an engineer today and an architect tomorrow. Too often, we put a tag on a man. If his ideas tend to drift from the mental niche in which we have placed him, we try to push him back in his cubbyhole.

I recently returned from the Soviet Union, where I found that the Russian concept of the individual is very similar to what ours was about 100 years ago. The Soviets may not subscribe to individual enterprise the way we do, but they do recognize an individual when they award him patents. Incidentally, there is nothing in Soviet law that would prevent an outsider from receiving a patent there. If I'm ever awarded one of their patents I'll be the first American to crack the barrier.

Because I am an individual, I am able to survive economically as an individual in America only by virtue of my patents. Thanks to our patent laws, and a good attorney, I haven't had my brain picked dry. (Unfortunately, there are too many bureaucrats in the government who take it upon themselves to judge patents.) I don't think

Peripatetic Explorer

there is any question but that the next decades are going to see a rediscovery of the individual by massive corporations and massive governments.

In the next decades we will not only see a rediscovery of the individual, but a great reorientation in our educational process—you might even call it a revolution. Take engineering. In the first place, an engineer should have the training and the ability to design a workable product. I don't think we should lose this concept. The idea that an engineer also should be an inventor is strictly political. Some people think that if you give enough money to MIT you will obtain a lot of inventions. You won't get one. I'm not saying that an individual engineer can't also be an inventor, but there is nothing in his training that would necessarily enable an engineer to invent. What have engineers ever "invented?" It wasn't an engineer who invented the airplane, telephone or electric light.

We Teach Nonsense

One of our big problems in the field of education is that we are teaching our children nonsense. Soon we will have to teach our children to unlearn rather than to learn. When I was a boy, the Wright brothers flew their first plane. Before that, my uncle told me it was all nonsense. "No man could ever fly," he said. Even after the great event at Kitty Hawk, scientists were trying to prove it a hoax. We have to start at the beginning when we educate our youngsters. Linus Pauling, for example, has a first-year chemistry class and he starts his freshmen by discussing what chemical discoveries were most recently uncovered. He believes that the latest is the simplest. We have the idea that the latest scientific discoveries are very complicated while the elementary material is easy. We should actually reverse this process. All the things that either don't work or we don't understand, we call elementary.

For example, we'll take our family on a picnic, watch the sun disappear behind a mountain and say, "My what a beautiful sunset!" In other words, we are admitting that we are about 500 years out of line with our own theory. If we're going to properly educate our youngsters I think we should begin by giving them some good answers at the outset. Children are a lot brighter than many parents and teachers think. By helping a child understand the world around him early in life, we'll save him a lot of headaches later.

Birth of the Industrial Designer

We have a great problem today educating not only our young people, but adults as well. As new industries emerge and as new segments of engineering gain prominence, the job of keeping the public informed is a tremendous one. One new group that began about 30 years ago has taken the name "industrial designers." They started on automobiles in the 1920s in an interesting way.

Fuller with PRODUCT ENGINEERING'S panel. At his left, editors Leerburger and Park; at his right, editors Koff and Kolb.

Businessmen and investors were betting on the financial success of the automobile. There were over 125 automobile companies shortly after the first world war, but mortality after mortality whittled down the field. As each successful company came into prominence the engineer-businessman ran into problems in high-production accounting; he didn't know how to estimate his capital needs or how to justify his tooling costs. Then around the mid 20s, Wall Street learned that to be successful in the automobile business the manufacturer had to know the base cost per car, depending on its weight; and that to mass-produce cars, the lowest possible price per pound had to be achieved. In 1925 it was learned that 135,000 cars a year had to be sold in order for the building and tooling costs, amortization, overhead and profits to parallel cost per pound of the material used in manufacture of these automobiles.

It was the discovery of this figure that enabled Dillon, Read & Co to put together the Chrysler complex. Since tools themselves can't go bankrupt it was easy to buy out dying companies and start producing and selling more than 135,000 cars a year.

At this point, Wall Street got tough and decided that, since production was so important, the auto business should be run by people who understand production problems. So they methodically kicked every inventor and designer out of Detroit and replaced them with production people. The Dillon, Read boys were smart. They said, "We can change the exterior of the car—but leave the engine and chassis alone." The inventors went off to Cleveland and Toledo and began making better brakes and carburetor—components—which the production people simply applied to the basic package. In time, industrial designers began making superficial changes to the exterior. This, then, became a "new" product every year. Today the industrial designer is simply an official packager, a "sex appealer." When a man becomes an industrial designer, he is doomed. Styling is a malignant growth in industrial evolution. Its pseudo-logic may betray our democracy through its economic debilitation.

NOW... Robbins & Myers Calculates a New Motor Design EVERY 1 to 6 MINUTES!

R&M Engineers Explore Hundreds of Design Combinations to Achieve OPTIMUM MOTOR PERFORMANCE!

How many ways *could* a motor be designed — a polyphase motor, for example? At least 27 basic variables offer 27^{27} (30 zeros) possibilities! Theory, of course, but still there's a colossal number even after obviously impractical designs are ignored. Working with slide rule, an engineer can calculate maybe four designs per day . . . and that's the time-consuming way it was done once. But now ROBBINS & MYERS engineers can explore hundreds of design possibilities, using their Data Processing System. With infallible accuracy, IBM's 20,000 digit "Magnetic Memory" is able to calculate a new motor design every one to six minutes! Because R&M engineers can now explore hundreds of design combinations before they make a final decision, you get the one motor that will deliver optimum on-the-job performance! And at no extra cost!

"Mechanized" mathematics at ROBBINS & MYERS also gives engineers more time for design *vision* and *decision*, which no machine can possibly provide . . . and enables them to improve existing motors by probing alternate design possibilities.

If you are ordering integral or fractional HP motors, or series motor parts, remember this fact: *the greater the number of practical design possibilities the manufacturer explores before the motor is produced, the better the motor will perform!* When your motor comes off the assembly line at ROBBINS & MYERS, you can be certain you are getting the best design possible, perfectly adapted to your requirements, and quality-built to perform dependably for years to come!

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1/200 thru 200 horsepower

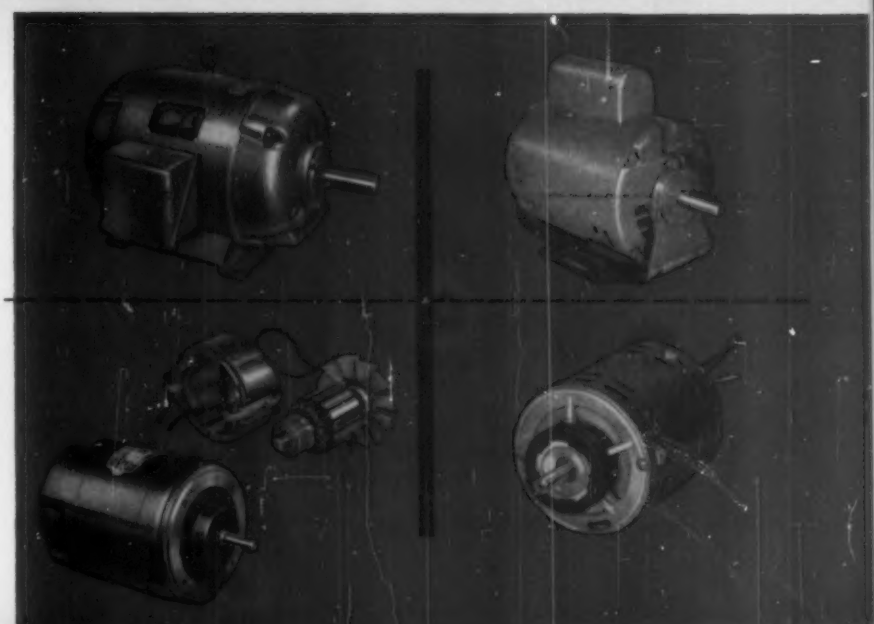
Design answers in seconds from IBM 20,000 digit magnetic memory!

Integral Motors (left), range from 1 to 200 HP in single-phase, direct current, polyphase, totally-enclosed fan-cooled, and explosion-proof types.

Standard Fractional HP Motors (right), are available in polyphase induction, capacitor start, resistance split-phase, and permanent split capacitor, in open and totally-enclosed types.

Precision-Made Universal Motors and Series Motor Parts (left), enable manufacturers of electric power-driven equipment to make the motor an integral part of their product.

Business Machine and Commercial Appliance Motors (right), are available in standard or custom designs.



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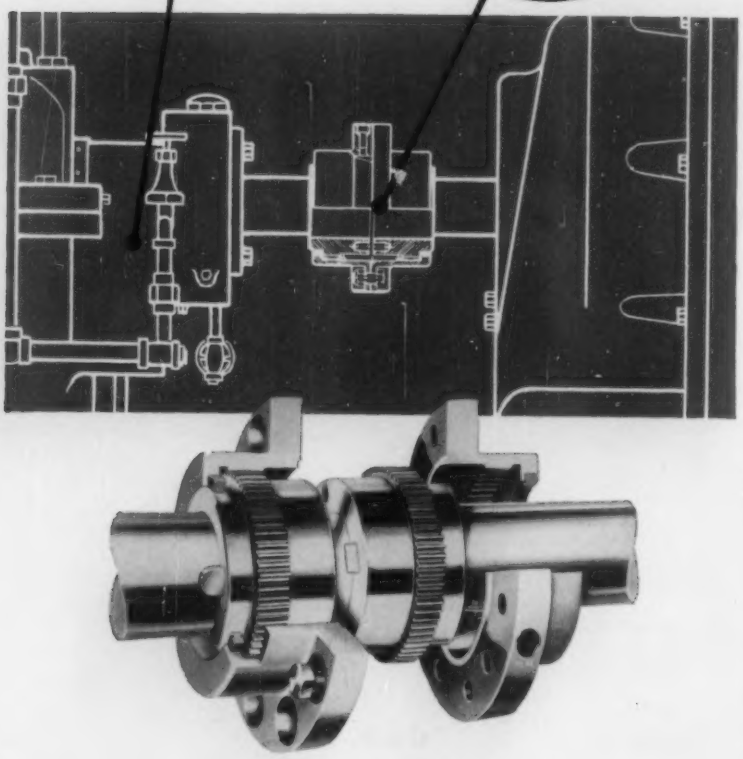

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Waldron gear couplings are available in a wide range of standard and special types for any service requirement, to provide complete protection and positive, trouble-free drive.

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28 CIRCLE 28 ON READER SERVICE CARD

READER TO EDITOR

Background of Reliability

To the Editor:

The May 16 issue of PRODUCT ENGINEERING has come to my attention because of its special 32-page report on Reliability. I have just begun to read this report and the section entitled "A Little History," near the beginning, has caught my attention. I cannot resist the temptation to make reference to some additional early reliability history. Having been concerned with a specific Navy missile project, during the years 1945 to 1951, and during an earlier affiliation, reliability became of specific concern to flight testing operations as early as 1947, at a time when literature directly concerned with this topic was nonexistent. A review of my files confirms that the RAND Corp of Santa Monica, California, under USAF subsidy, published the first of a series of (classified) reliability reports as early as 1949.

The first reliability presentation at a national gathering, to the best of my knowledge, was made during the Symposium on Improved Quality Electronic Components, May 9-11, 1950, sponsored by IRE, AIEE, and RMA, by Charles R. Banks, Aeronautical Radio Inc, entitled "Reliability in Airborne Equipment." Charlie Banks, during his annual two-week active-duty period required by his Naval Reserve status, studied the missile reliability of the project with which I was connected in 1948 and 1949. As Chief Engineer at Aeronautical Radio, he was specifically interested in electronic-equipment reliability as demonstrated in airlines operation. This was the area covered by his 1950 presentation.

The first talk on military reliability, to the best of my knowledge, was given by Commander Hamilton O. Houck of the Naval Bureau of Ordnance at a local meeting of the Pittsburgh Section of the IRE in early February 1951. I believe the first presentation at a national gathering on military reliability was my paper "Reliability Testing of Airborne Systems and Components" presented at the 1951 National Convention on Airborne Electronics, Dayton, Ohio, May 25, 1951. Although this paper was not formally published, over a hundred copies were distributed on request to most of the military establishments and nearly all of the missile manufacturers. The Armed Services Technical Information Agency identifies this paper as ASTIA-ATI-154770. It is interesting to note that Commander Houck's presentation in Pittsburgh was based on Robert Lusser's first reliability presentation, NAMTC Technical Report No 75, July 1950, entitled "Study of Methods for Achieving Reliability in Guided Missiles," and my Dayton presentation used three slides from this Lusser report.

Turn-about being fair play, Mr Lusser in his third reliability publication, NAMTC Technical Memo No 70, June 20, 1952, entitled "Planning and Con-

ducting Reliability Test Programs for Guided Missiles," made use (with appropriate credit) of one of the illustrations from my paper entitled "Application Engineering For Improved Electronic Reliability in Guided Missiles," presented at the 1952 IRE National Convention (Mar 6, 1952) and later published in the Transactions of the IRE Professional Group on Quality Control, Vol 1, p 41, Aug, 1952.

It is also interesting to note that the session in which my 1952 paper was given was entitled "Symposium on Reliability of Military Electronic Equipment," and contained four papers generally on this subject. I believe each of the papers was prepared after having been specifically requested.

—W T. Sumerlin
Manager, reliability administration
Philco Corp, Philadelphia

More Gear Data

To the Editor:

I have read Mr B. Bloomfield's article "When You Need Noncircular Gears," Mar 14, p 59, and found it very interesting. He says, "Even now, few handbooks or texts on mechanical design include information on such gears—and then too briefly to instill confidence." This is not quite correct. The same kind of gears and, moreover, gears with wheels of any desired shape have been treated and described in my doctor's dissertation, "Noncircular Cylindrical Gears," published in *Acta Polytechnica*, Mechanical Engineering Series, Volume 2, No. 10, Stockholm 1953. It might also be of interest to you that this treatise has been followed by a new one that in similar way treats noncircular bevel gears.

—Uno Olsson
Ludvika, Sweden

COMING EVENTS

JUNE

20-24 . . . . American Society for Engineering Education, 68th Annual Convention, Purdue Univ, Lafayette, Ind

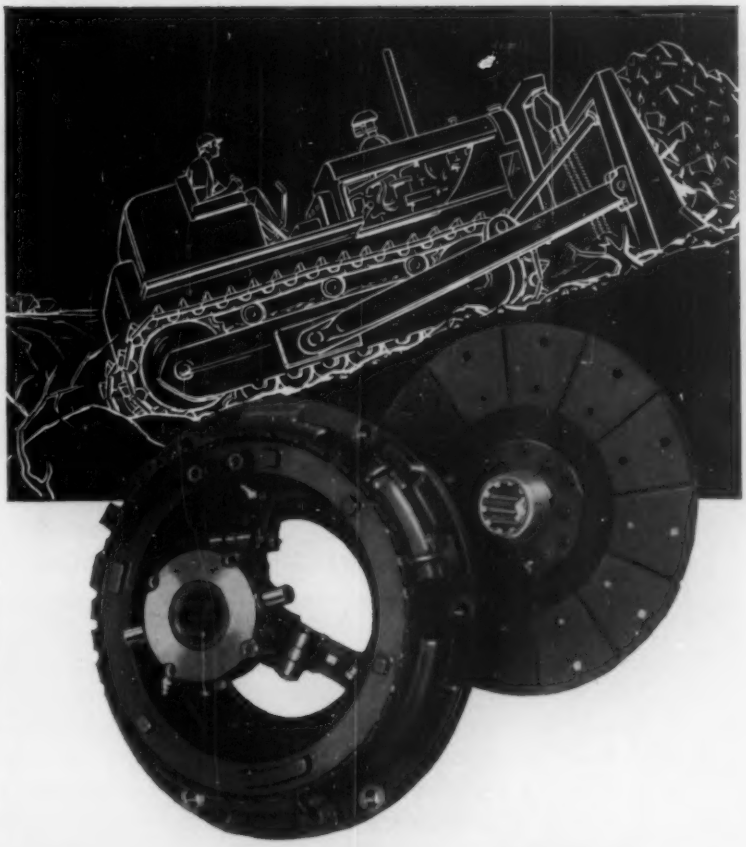
27-29 . . . . Institute of Radio Engineers, 4th National Convention on Military Electronics, Sheraton Park Hotel, Washington, DC

27-July 1 . . . . American Society for Testing Materials, 63rd Annual Meeting, Chalfonte-Haddon Hall Hotel, Atlantic City, NJ

AUGUST

1-3 . . . . Institute of Radio Engineers, 4th Global Communications Symposium, Statler-Hilton Hotel, Washington, DC

28-Sept 1 . . . . American Society of Mechanical Engineers, International Heat Transfer Conference, University of Colorado, Boulder, Colo



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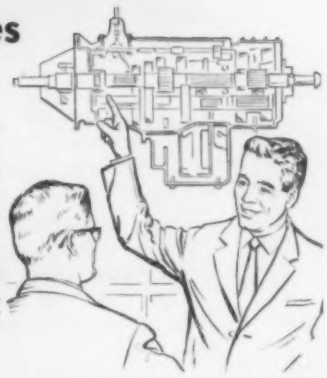

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MOTOR USER'S CASE HISTORY

"We've used BODINE MOTORS for 38 years!"

. . HEDMAN COMPANY

"Yes, we started using Bodine Motors about the time John Barrymore was breaking records on Broadway with 101 performances of Hamlet. That was in 1922 . . and we've been using Bodine Motors ever since. Why? Because we need motors that are small in size, sturdily constructed, long lasting, trouble free, and quiet. And they have to supply the necessary high torque needed. Over the years we have found that Bodine Motors have consistently met these requirements. And, there's another important thing in favor of Bodine: Their engineering staff has always been extremely important in helping us with our motor problems."

. . C. W. Johnson, vice-president, Hedman Company

Here's Hedman's latest application of a Bodine Motor!

This is a Keypunch Protector. It consists of a Hedman Royal Keyboard Check Protector with a built-in IBM code key punch mechanism. As shown in the photo to the right, it automatically punches the correct amount into tab card checks, receipts, and register copies at the same time it imprints the amount. Hedman engineers selected the Bodine type VCF-12 motor because they need a small, quiet motor that will last a long time and give trouble-free service.

Bulletin tells story of late model business machine motor.

Here's the story of Bodine's latest model business machine motor . . the FSE-23. It's only 2 9/16" high . . weighs only 1 pound 11 ounces . . and delivers plenty of power. It fits into minimum space because it's rectangular in shape. Ask for your copy of Technical Bulletin #1034. Bodine Electric Company, 2510 West Bradley Place, Chicago 18, Illinois.

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ROLLER CHAIN

The Roller Chain that can take more because it's built to give more!

DIAMOND *Tuf-Flex* is a rugged new *straight link* power transmission chain—especially engineered to provide extra durability and unusual flexibility to meet the strenuous service demands of heavy construction machinery. It is especially suited for equipment such as concrete transit-mix trucks and all types of power excavating shovels.

Proven advantages of *Tuf-Flex* are:

- **Longer service life**
- **Higher working load capacity**
- **Will accept greater misalignment of sprockets**
- **Greater capacity for shock and peak loads**
- **Easier chain connection**
- **May be used on existing sprockets of the same pitch**

*The trademark ***Tuf-Flex*** is the property of Diamond Chain Company, Inc.

Greater clearance between inside and outside linkplates, and between pins and bushings, permit extra flexibility and reduce stiffness after periods of idleness or exposure.
Up to 4° lateral displacement from center line per 4' of chain (above) and up to 8° of twist (right) accommodate sprocket misalignment due to twisting of machine's frame.
Tuf-Flex straight linkplates transmit loads in a *straight line*, utilizing maximum load capacity of linkplates, pins and bushings.
American Standard Dimensional Specifications permit DIAMOND *Tuf-Flex* to operate over existing sprockets cut for American standard roller chains, of the same pitch, or equivalent offset side bar chains.
DIAMOND Tuf-Flex
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Write today for new ***Tuf-Flex*** Bulletin No. 2600. Gives engineering features, construction details, specifications and prices.

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when and where you need it

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give you the clean, fast, concentrated heat you need. A complete selection of sizes, sheaths, leads, terminals, wattage and voltage are offered to satisfy your most particular needs. And all Hotwatt Cartridges have these features as well as many others:

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- ✓ Arrangement of heating element assures maximum heat transfer, minimum core temperature, and consequently faster heating.

Because of the exclusive design features of Hotwatt Cartridge Heating Units, they can be shipped to you faster . . . whether you order standard or special units in any quantities. Hotwatt also offers low-cost ceramic-body units to meet your specifications.

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FOR YOUR INFORMATION (personal)

Cruising in Style

Now the auto driver can take his foot off the accelerator and relax while cruising. A device that holds the throttle in the desired position is being marketed by Fixogas Corp, PO Box 99, Mt Kisco, NY. It's attached to the floor of the car, with the main body just in front or to one side of brake and accelerator pedals; with one arm extending under, and hooked up to, the brake pedal, and the other attached to the accelerator. Then, all that's necessary, says Fixogas, is to depress the accelerator to the desired position, step lightly on the brake pedal, and the accelerator stays where you put it. To slow down, or disengage the unit entirely, just touch the brake again. The price: $14.95.

THROTTLE CONTROL attaches to brake and accelerator pedals, holds the line while you enjoy the passing scenery.

Don't be fooled by a btu

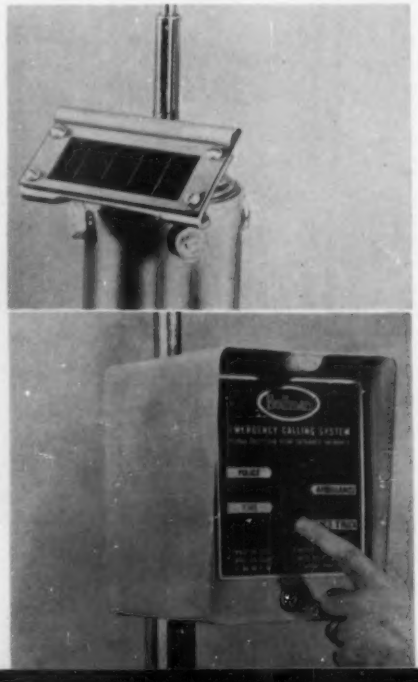
Does the air conditioner keep your room as cool as the btu figures indicated it would? If not, and especially if you're planning a purchase instead of already living with one, the National Better Business Bureau says you'd better read those ads carefully. Here's why:

Some conditioners claim btu ratings substantially greater than ratings of the units based on NEMA or ARI Standards. These inflated ratings are obtained by various unorthodox procedures. Among them are:

- Testing the units at higher temperature and humidity than specified under NEMA or ARI Standards, giving an inflated btu-per-hour capacity.
- Using "btu 24-hour" ratings in contrast to the standard "btu-per-hour." The "24-hour" ratings do have a function in estimating cooling loads for air-conditioning installations (they're based on operation of an air conditioner over a 24-hour period under continuous thermostatic control). But they should not be used for comparison with standard performance ratings. They give a figure 30% higher than the btu-per-hour rating of the unit, tested in accordance with the NEMA or ARI Standards.

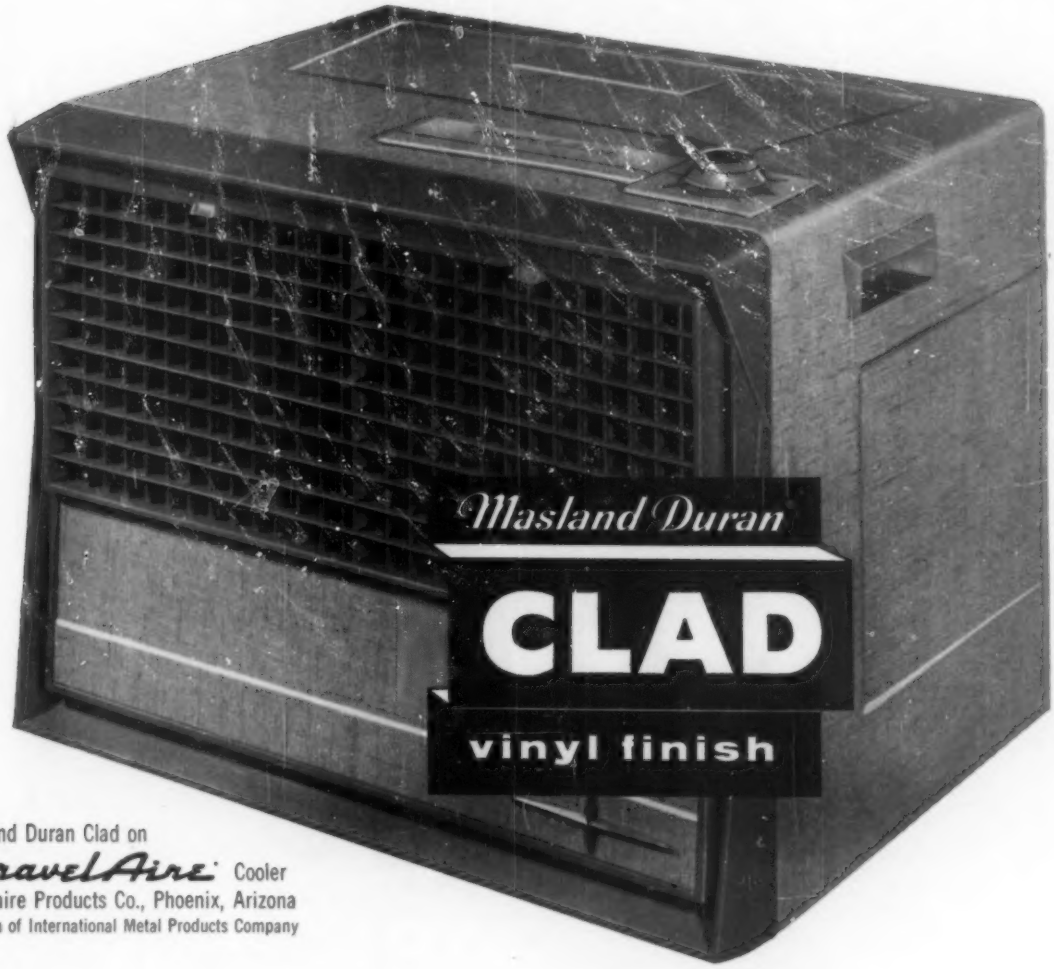
Sun-powered S.O.S.

A highway-emergency call system that's powered by solar energy has been designed by Hoffman Electronics Corp. The transmitter (see photos) consists of a conventional call box, designed for mounting on pole or lamp post, with pushbutton for summoning fire, police, ambulance, or service truck. But it doesn't hook up to line power. Its juice comes from a one-watt nickel-cadmium power pack that's kept charged by 5 tiny silicon cells mounted above it. Hoffman claims 5 min. of sunlight supplies enough current for one code message and the battery pack can store enough power for 150 transmissions. —ARG



SOLAR CELLS, mounted on battery pack, power the signal system installed beneath it.

A BUILT-IN SALES ADVANTAGE FOR YOUR PRODUCTS, TOO



Masland Duran Clad on
TravelAire Cooler
Metalaire Products Co., Phoenix, Arizona
Division of International Metal Products Company

This new and *integral* finish not only spurs product sales . . . it cuts costs, too. Can be laminated permanently to metal. Texture and color remain unimpaired by forming, crimping, stamping, drilling, etc. No new equipment required. Can even eliminate the need for spray booths, and baking ovens. Cleans easily. Mail coupon for samples.

Industrial Products Division
THE MASLAND DURALEATHER CO., Dept. PE, Philadelphia 34, Pa.

CIRCLE 33 ON READER SERVICE CARD

The Masland Duraleather Co., Dept. PE
Amber & Willard Sts., Philadelphia 34, Pa.

Please send information and samples of Clad

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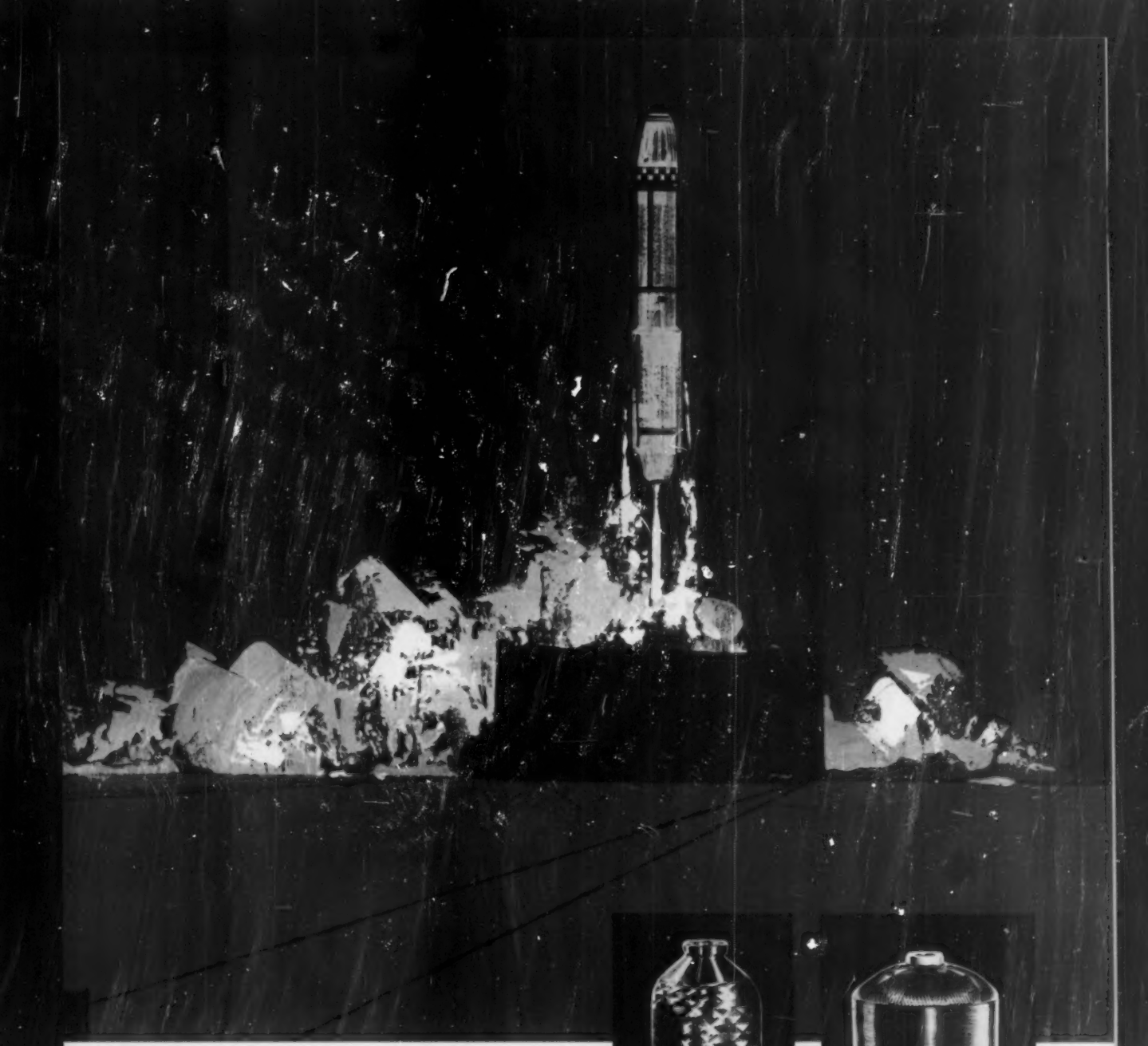
CIRCLE 34 ON READER SERVICE CARD →

NS SPECIAL WIRE (575,000 psi) WRAPS

In the development of solid-fuel rocket cases, a leading manufacturer fabricated and experimented with welded steel and glass fibers, as well as many steel wire specimens, to find a fuel case material with the most favorable strength-to-weight ratio for fuel case applications.

EARLY DEVELOPMENT STAGES—At the outset of their testing program, the rocket manufacturer asked National-Standard to develop .004″ wire with 575,000 psi, the ultimate tensile strength required of steel wire to provide the strength-to-weight ratio needed. The wire was to be made into tapes of uniformly-stressed wires, coated with epoxy resin to separate the wires, and wound over collapsible mandrels to form the fuel case.

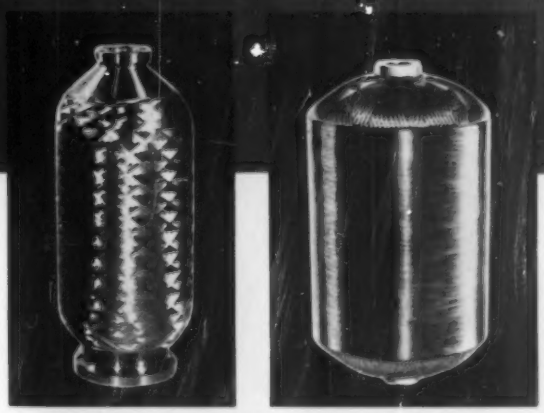
NATIONAL-STANDARD ENGINEERS produced .004″ high-carbon steel wire that met every specification, after intensive testing with many types of wire and finishes. Special wire developed by NS met rigid size tolerances, residual twist and controlled cast requirements.



ROCKET FUEL CASES

The end result of NS—customer cooperation was the ability to produce wire-wrapped rocket cases with very high hoop stress and lower cost than those being produced by other methods. And the fuel case manufacturer is able to provide maximum case-to-case reliability.

EXPERIENCED ENGINEERING HELP of this kind is available to you from National-Standard to meet special or unique high-quality wire applications. Write for additional information to National-Standard Company, Niles, Michigan.



WIRE-WRAPPED ROCKET CASES are wound over collapsible mandrels using a number of strands of very high strength, small diameter wire formed into tapes.

NS NATIONAL STANDARD COMPANY

Manufacturer of Specialty Wire and Metal Products

NATIONAL-STANDARD COMPANY

Niles, Michigan

Fafnir Ball Bearings with triple Plya-Seals help implement makers get

Simpler, more efficient design in disc tillage equipment

The use of prelubricated and sealed ball bearings has become widespread in farm equipment. Severe operating conditions make use of these ball bearings especially advantageous for farm service.

At one time disc harrows, for example, used plain bearings exclusively. But exposure to all kinds of weather, and the heavy soil-packing conditions of disc harrow service brought on rapid bearing wear and increased drag. Frequent relubrication was necessary.

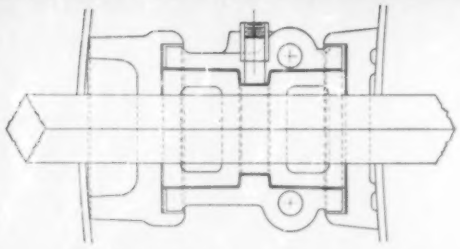
Working with farm implement makers on developing ball bearings for disc harrows, Fafnir engineers were faced with an extremely severe bearing sealing problem. Spacing of the discs could not be changed, although relocation of the hangers was permissible. The result was the development of Fafnir Tri-Ply-Seal Ball Bearings—a wide type bearing, prelubricated, and equipped with sets of triple Plya-Seals.

Made of tough, flexible, Buna-N rubber impregnated fabric, these seals ride in firm, constant contact with the ground inner ring of the bearing. Dirt, moisture, and other contaminants are effectively sealed out, and the factory-packed lubricant is sealed in. Bearing maintenance and service time are drastically reduced; over-all efficiency is increased. In some actual applications, the bearings have given trouble-free service for 12,000 hours.

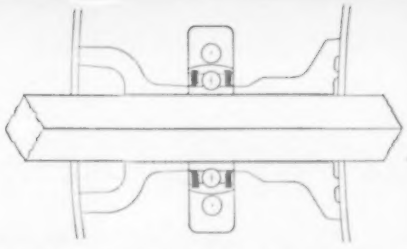
Manufacturers were quick to recognize the advantages of triple Plya-Seal design. In addition to saving servicing time (no relubrication necessary) and cutting down on frictional drag, the bearings simplify hanger and spool design and allow increased clearance for trash. The spherically ground outside diameter of the bearings assures self-alignment at mounting, eliminating bearing cramping.

Fafnir engineers have helped manufacturers throughout industry meet bearing requirements and improve product performance. For information about the ball bearings described here, or for help with problems you may have, contact the Fafnir Branch Office nearest you. Or write The Fafnir Bearing Company, New Britain, Connecticut.

Fafnir Tri-Ply-Seal Ball Bearings for round or square shafts feature triple Plya-Seals for protection against contaminants and loss of lubricant.



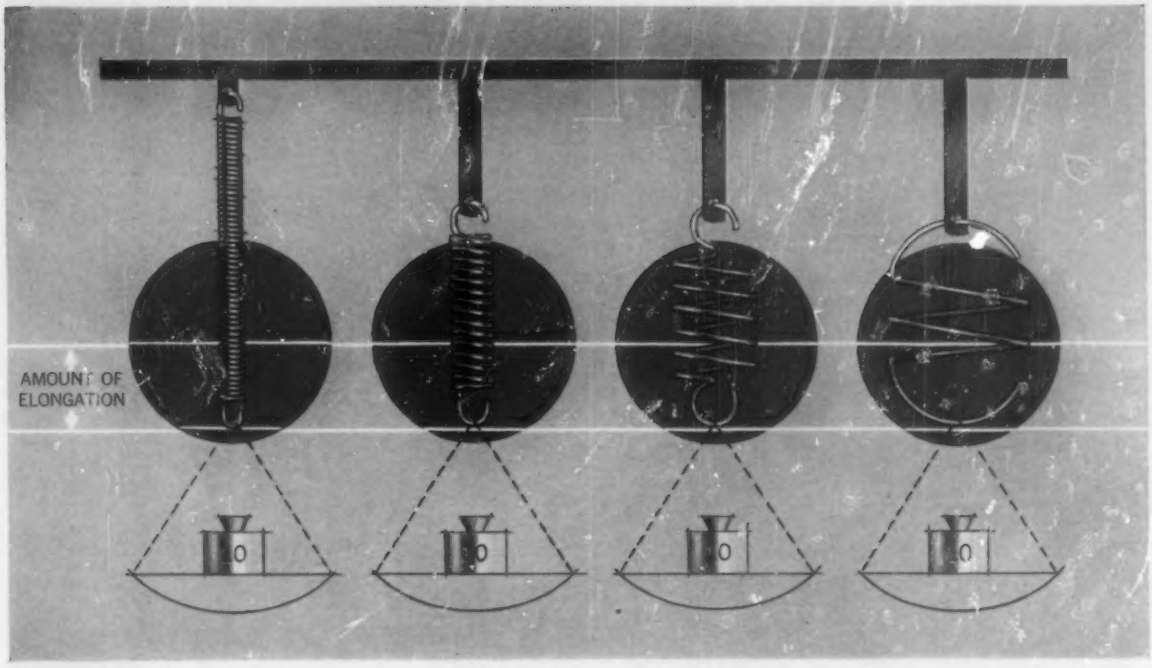
BEFORE—An old-style, plain bearing used on disc harrows. Rapid wear, increased lubrication, and increased drag reduced efficiency.



AFTER* — Fafnir Tri-Ply-Seal Ball Bearings simplify spool design, increase bearing life, and cut down on maintenance and service time.

*Although a cast iron housing is illustrated, in many applications Flangette mountings are preferred.

FAFNIR BALL BEARINGS



Spring shape and performance— or what does Spring Index mean?

One man distributes his 150 lbs. over a lean 6 ft. frame; another packs the same avoirdupois within a stocky 5 ft. 6 in. height. In a man, this might be expressed as the ratio of height to belt size. In a spring, it's a handy little ratio D/d, that of mean coil diameter to wire diameter. The illustration shows it quickly—same load—10 lbs.; same deflection—0.4 in. But in shape they range from the long thin spring at left with 75.8 coils and a spring index of 3, to the short fat spring at right with few coils and an index of 12. Application of the index ratio is particularly useful where space restrictions exist.

Our long years of specialization have developed many short cuts to spring specification to make your work easier. For general reference purposes write for pamphlet "Spring Design and Selection in Brief."

5810

Associated Spring Corporation — General Offices: Bristol, Connecticut

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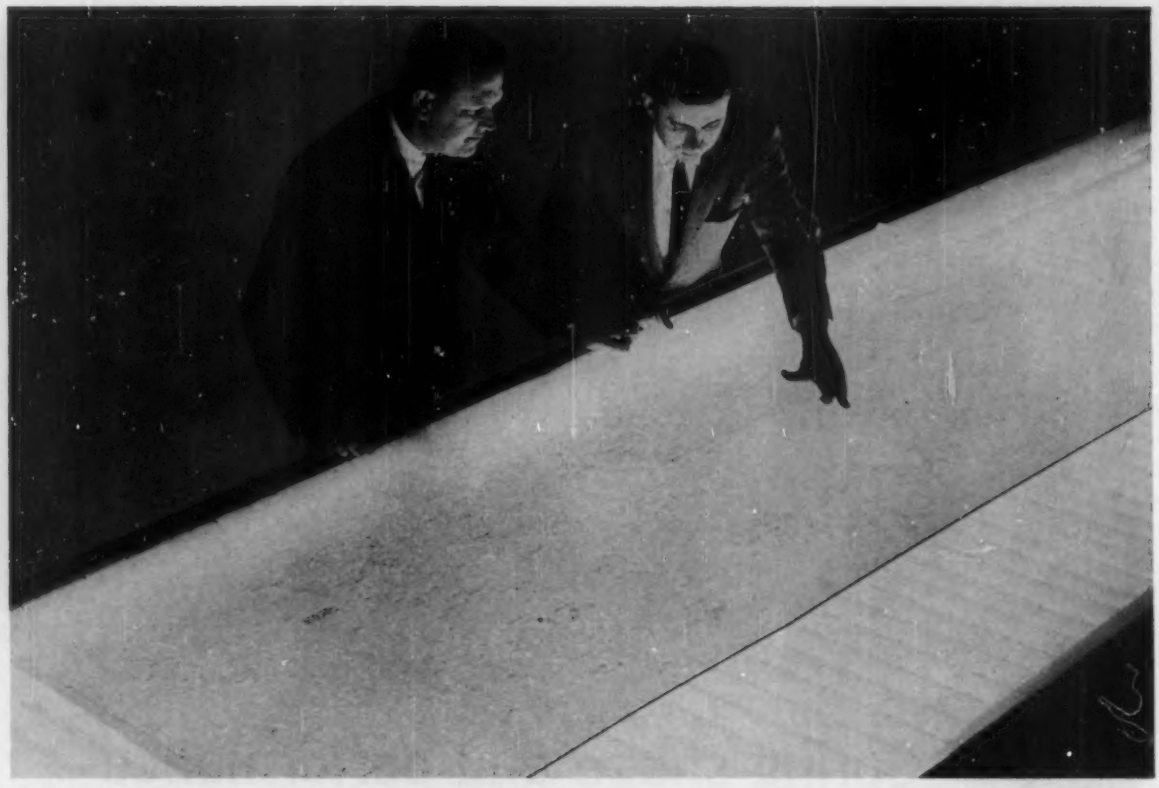

At light-table, Lee E. Zeunen (right) and Du Pont Technical Representative Wray Hushebeck examine a finished intermediate. States Mr. Zeunen: "We've added a number of new accounts because of better service at lower prices—made possible by CRONAFLEX."

"Durability, versatility of CRONAFLEX® helped us double production last year, while cutting costs 50%"

—Mr. Lee E. Zeunen, General Manager, Capitol Reproductions Inc., Detroit, Mich.

Chief among the responsibilities of Capitol Reproductions Inc. is the duplication of templates of every description for leading automobile manufacturers. "Because of its outstanding durability and dimensional stability," reports Mr. Zeunen, "we've been able to utilize CRONAFLEX in much of our template work. This alone enabled us to pass along to our customers end-cost savings of as much as 50%."

Mr. Zeunen finds that CRONAFLEX saves time and money other ways as well. "For example," he explains, "what were once 15-minute exposures now take us *30 seconds* with CRONAFLEX. And, because this film is so easy to handle and process, we're able to offer our customers same-day service on jobs that used to require 3 or 4 days!"

Operating on a 'round-the-clock basis, Capitol uses CRONAFLEX in providing complete engineering reproduction services. "Adhering, as we must, to rigid tolerance specifications," continues Mr. Zeunen, "we depend on CRONAFLEX for consistent uniformity. In addition, better resolution and equalization of line densities have improved the quality of finished work considerably. In short, we've found that CRONAFLEX permits us to deliver precision reproductions faster and cheaper."

Explore the many ways CRONAFLEX can speed production, improve quality and cut costs in *your* operation. For detailed information on the full line of CRONAFLEX films, contact your Du Pont Technical Representative. Or write: E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, Wilmington 98, Delaware.

DU PONT

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Better Things for Better Living
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No coil burnout with SPEED KING®

...pilot operated control valves

• Built to JIC standards • interchangeable pilots • choice of mounting types, optional features • ac or dc, any voltage • ¼ to 1 in. NPT

SPEED KING solenoid pilot coils, potted in molded resin, are unconditionally guaranteed against coil burnout for the life of the valve! And, Speed King pilots are totally enclosed, and sealed against entrance of dirt or moisture . . . valves are fully air-operated for speed and dependability . . . feature a hard-chrome plated stainless steel plunger floating in O-rings, to eliminate wear-producing metal-to-metal contact.

For multi-million cycle dependability, specify Valvair® SPEED KING control valves.

8111-3

Write for free Bulletin SK-100. Address: Bellows-Valvair, Akron 9, Ohio, Dept. PE-660.

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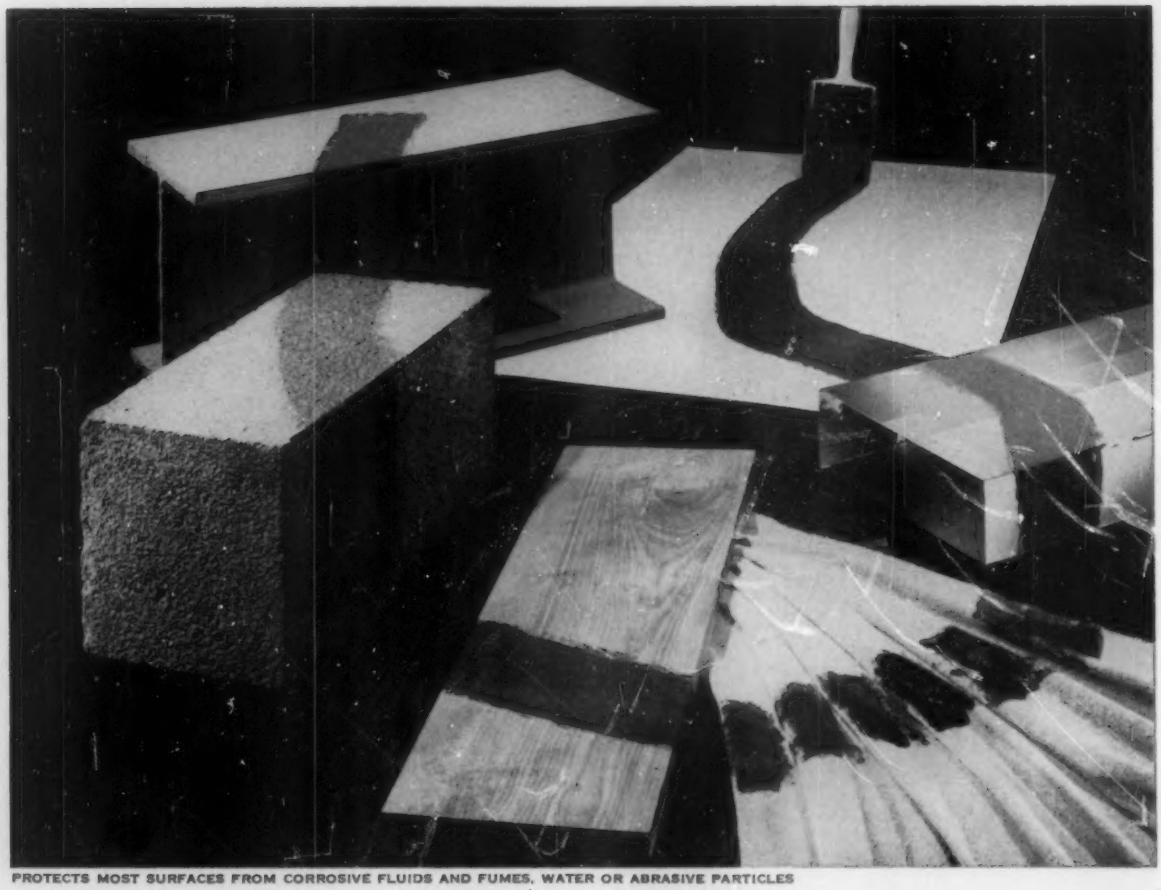
DIVISIONS OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

CIRCLE 39 ON READER SERVICE CARD

NEWEST WEAPON IN THE WAR AGAINST CORROSION AND ABRASION!

Coro-Gard® 1706

BRAND PROTECTIVE COATING



PROTECTS MOST SURFACES FROM CORROSIVE FLUIDS AND FUMES, WATER OR ABRASIVE PARTICLES

From the Research Laboratories of 3M comes a remarkable new coating to fight corrosion—CORO-GARD 1706 Brand Protective Coating. This neoprene rubber based coating air-cures to a tough, rubbery, protective film with exceptional resistance to corrosive fluids and fumes, water and abrasion. It maintains exceptional adhesion, flexibility, corrosion and abrasion resistance even after these strenuous test conditions: 2000-hour salt-spray attack; 20 weeks' submersion in 20% solution of hydrochloric acid; six-month weather exposure in Miami, Florida.

CORO-GARD 1706 Coating speeds production, provides unusually high coverage to cut costs. It brushes as easily as paint, is self-priming, yet goes on vertical surfaces with minimum sagging. For steel, aluminum, wood, concrete, cloth and some plastics—wherever corrosion or abrasion must be fought—specify new CORO-GARD 1706 Coating. It provides maximum protection at low cost.

For complete performance data without obligation, write today on your company letterhead to: AC&S Division, 3M Company, Dept. SBS-70, St. Paul 6, Minn.

"Coro-Gard" is a reg. TM of 3M Co.

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

SQUARE D announces NORpak

—A SIMPLER, FASTER, STATIC CONTROL!

NORpak is a significant advance in the field of static switching. Like other static systems, **NORpak** performs the functions of machine tool relays, stepping relays, latching relays and timers —all without contacts or motion of any kind. Like other static systems, **NORpak** is ideal for applications where speed is important—where reliability and long life are essential—where conditions make conventional magnetic devices impractical.

But unlike other static switching systems, NORpak offers these important advantages

EASIEST TO APPLY

The transistor NOR unit is the basis of **NORpak.** All logic functions—AND, OR, NOT, MEMORY—can be accomplished with combinations of this single NOR unit. **NORpak** is *not* complicated—it's easy to apply to conventional circuits. Units are color-coded for quick identification. Simple DC circuit eliminates worry about phase relationships.

UNMATCHED SPEED

NORpak provides switching at rates up to 25,000 per second—faster than any other industrial static system.

SMALLEST COMMERCIAL PACKAGES

NORpak is available in the form of individual components, or in completely engineered systems. Components are offered in 6 and 20 paks, require only 1/4th the equivalent relay panel space, and weigh less than components of other static systems.

EXTRA DEPENDABILITY

NOR units have been time-tested in computer use for years. They are not subject to wear, will give top performance indefinitely, and provide unfailing circuit fidelity.

SIMPLE TO USE

Optional monitor lights give visual evidence of proper performance. Simple dynamic sequence tester checks individual NOR units in operation.

EXPERT APPLICATION HELP

Field specialists, factory-trained in all aspects of **NORpak** can give you on-the-spot answers to any application questions.

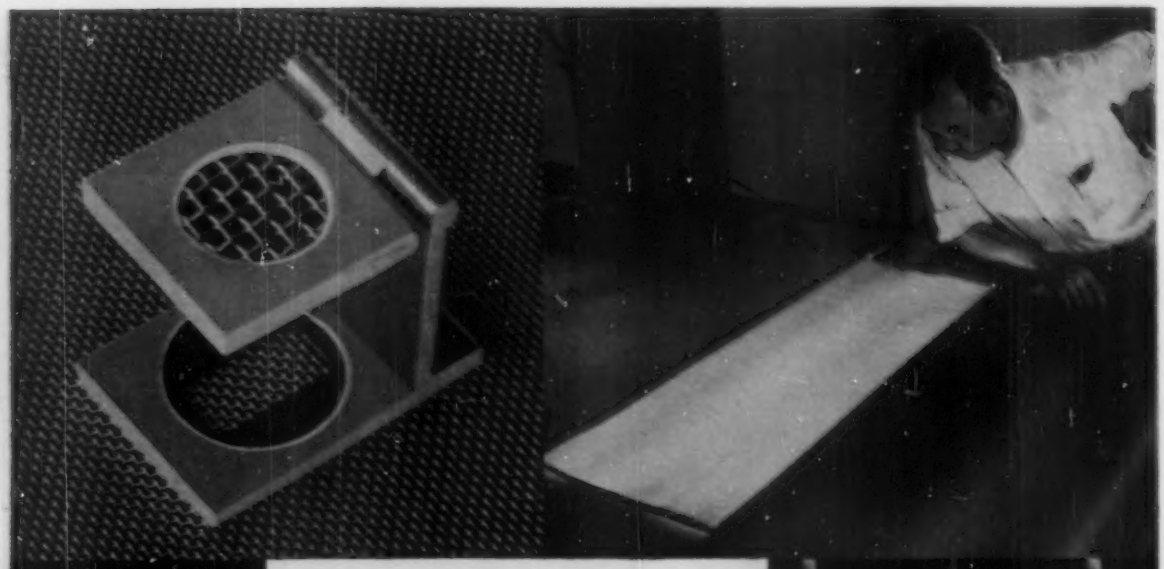
NORpak is available as individual components for application to specific control functions, or as completely engineered systems ranging from the smallest to the largest panels

Write for the complete story on **NORpak** *—its theory, application and operation... Square D Company, 4041 North Richards St., Milwaukee 12, Wisconsin*

D ...design leadership

SQUARE D COMPANY

wherever electricity is distributed and controlled



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CAMBRIDGE does . . .

. . . because exact mesh count and mesh size are the trademarks of Cambridge INDUSTRIAL WIRE CLOTH.

But, quality isn't the whole story. When you call Cambridge for industrial wire cloth, you also get service . . . prompt answers to your inquiries . . . quicker deliveries . . . and an experienced Field Representative who follows up your order to make sure our product is giving you the best possible service. Let us quote on your wire cloth needs. We manufacture wire cloth from any metal or alloy—including titanium—in nine basic weaves. Very likely, we have what you require in our warehouse right now. For samples or more information, call your Cambridge Field Engineer...he's listed in the yellow pages under "Wire Cloth". Or, write for FREE 94-PAGE CATALOG.

The Cambridge Wire Cloth Co.

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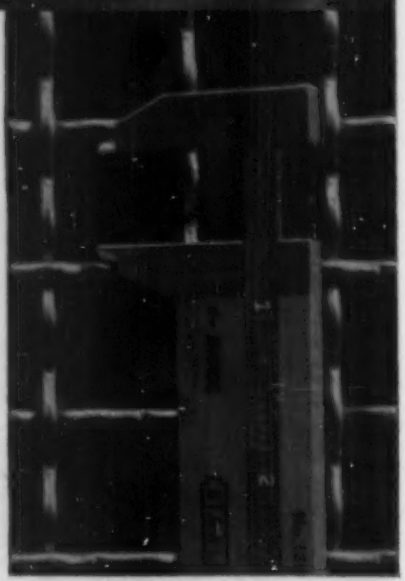
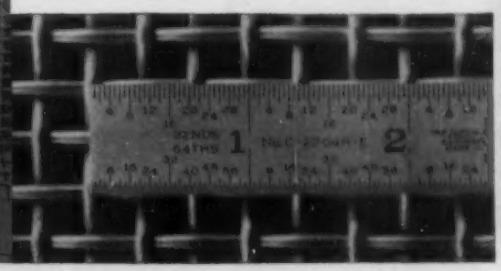
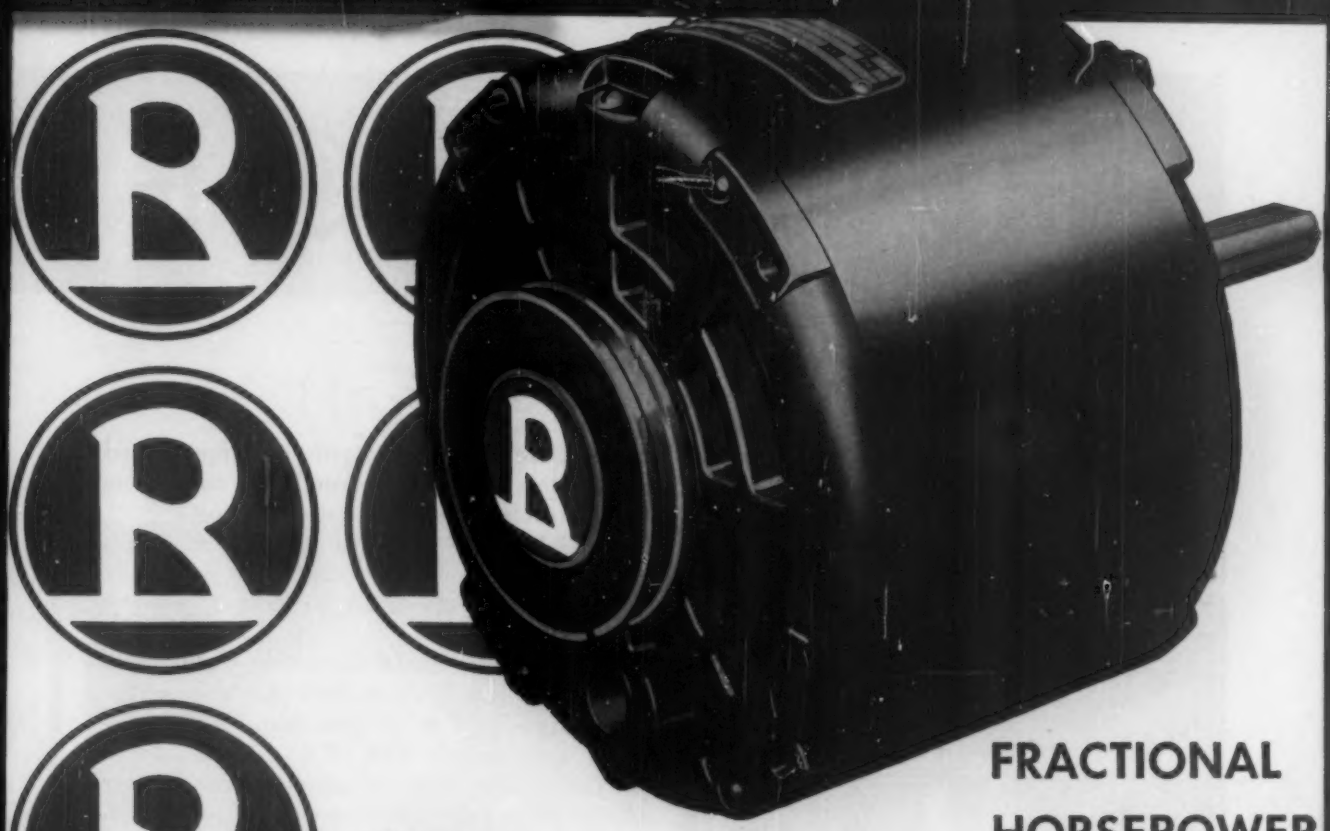
Manufacturers of Wire Cloth, Metal-Mesh Conveyor Belts, Wire Cloth Fabrications







R is for Redmond

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The Name to Specify When You Need Trouble-Free, Whisper Quiet, Economical Motors

Redmond specializes in just one thing—the design, development, and manufacturing of fractional horsepower electric motors—we make no products to compete with you. Redmond motors are tailor-made to fit each specific application exactly, and therefore give you the most economical, efficient, high-quality, long-life motors available.

Redmond's complete and modern application laboratory is available to custom-tailor motors for customers and prospects. Regional offices are staffed by qualified sales engineers who can conduct complete tests and assist you in application engineering. Contact us at Owosso, Michigan, and the Redmond Sales Engineer in your area will call you at once.

NEW CATALOG

New 12-page catalog describes and illustrates basic line of Redmond fractional horsepower electric motors, blowers, and special products. Send request for your free copy to Redmond Company, Inc., Owosso, Michigan

The Standard of Dependability

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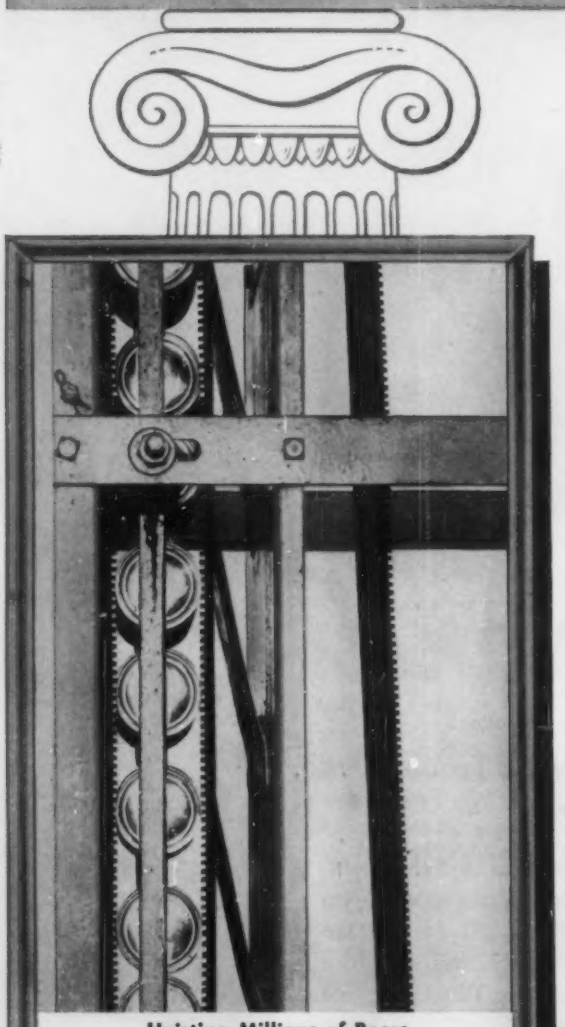
REDMOND

THE BIG NAME IN SMALL MOTORS

HAULS OF



Hoisting Millions of Beers —straight up—with never a slip

At the giant Anheuser-Busch brewery, this pair of U.S. SteepGrade Conveyor Belts lifts 16-oz. cans of beer *at a 90-degree angle.*

"No other belt could have accomplished better performance. It's nothing short of spectacular," says the manager of the brewery.

As the 1-lb. cans come from the pasteurizer slippery and wet, they roll onto the vertical can conveyor where SteepGrade carries them straight up and onto an incline to the carton-filling machine. Cans don't slip at all, even when the conveyor is stopped.

The secret is SteepGrade's exclusive "gripper cleat" construction—a molded, integral part of the belt itself. These thousands of "gripper cleats" hold the cans firmly, yet gently. This means far less pressure, far less belt speed is required. Damage to cans and print smearing is eliminated. And the more efficient operation saves electric power, lengthens belt life.

HERE are on-the-job stories of three United States Rubber Conveyor Belts, taken from "U.S." belt records in package handling.

These belts are just some of the "U.S." stand-outs which demonstrate, year after year, why "U.S." is the world's largest producer of conveyor belts.

For steady, day-in-and-day-out dependability in conveyor belting, it always pays you to secure the advantages of "U.S." Engineering. "U.S." Engineers work directly with "U.S." Distributors or original equipment manufacturers to assure their obtaining the right belt recommendations for each type of conveying.

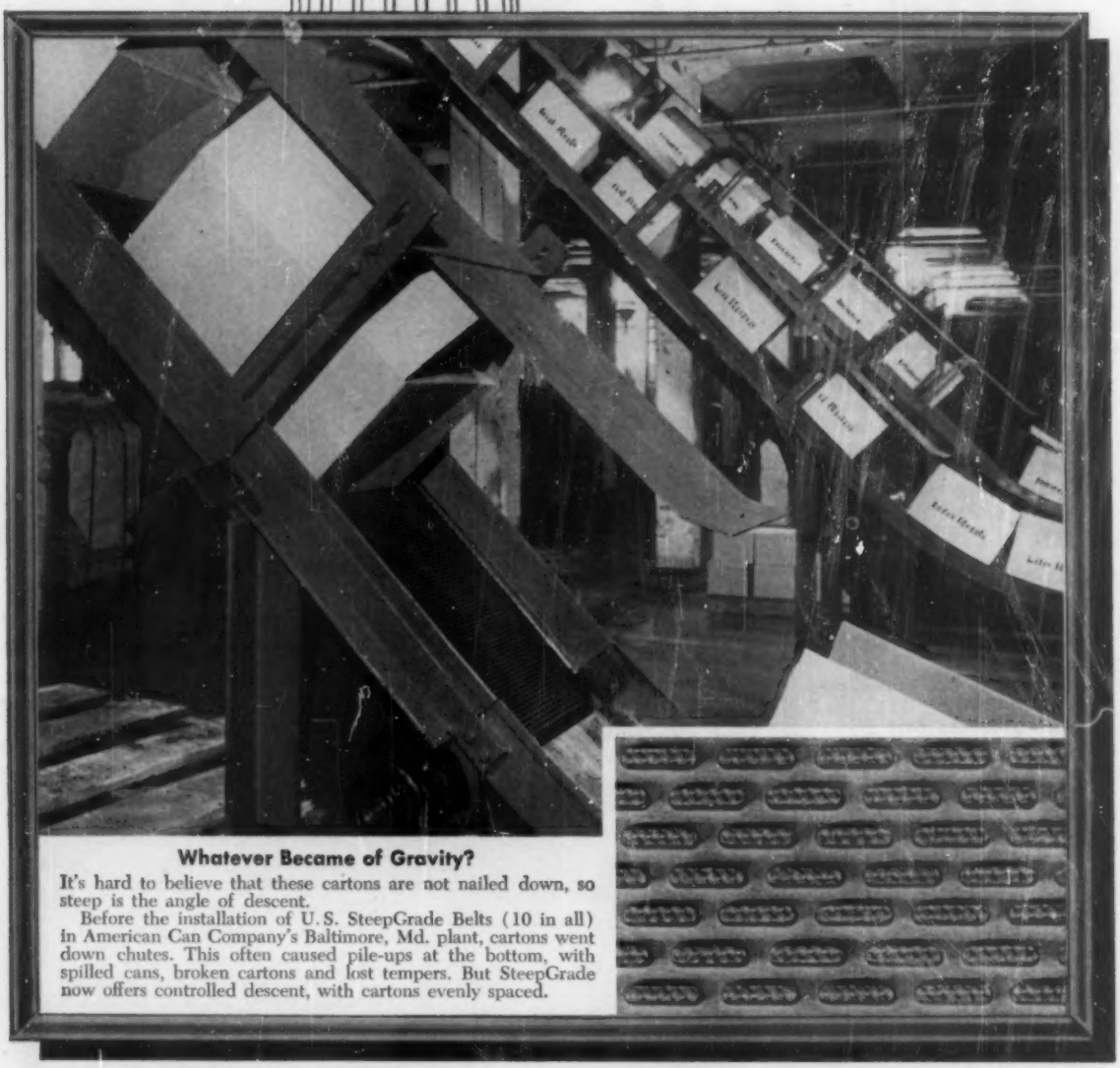
The most comprehensive belting engineering information in the industry is available through your "U.S." Distributor. It will pay you to check with him.

U.S. STEEPGRADE, serving the world's great airlines

Next time you're at an airport chances are you'll be able to see U.S. SteepGrade Conveyor Belting in action. You'll see it carrying cargoes on steep inclines and declines—as steep as 45 degrees. It speeds up loading, reduces manual labor for today's leading airlines.

Again notice the gripper cleats in SteepGrade. They cannot be torn off by heavy boxes. SteepGrade is weather resistant, will not stiffen in extremely low temperatures and is self-cleaning.

FAME



Whatever Became of Gravity?

It's hard to believe that these cartons are not nailed down, so steep is the angle of descent.

Before the installation of U.S. SteepGrade Belts (10 in all) in American Can Company's Baltimore, Md. plant, cartons went down chutes. This often caused pile-ups at the bottom, with spilled cans, broken cartons and lost tempers. But SteepGrade now offers controlled descent, with cartons evenly spaced.

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

CIRCLE 45 ON READER SERVICE CARD

(Advertisement)

RB&W FASTENER BRIEFS

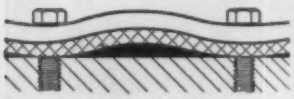
RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By Fred E. Graves

Fastening of gasketed joints

The right fastener for a "flexible" joint rests on type of gasket material and its compressibility. Total preload on all the fasteners in the connection must be enough only to compress the gasket and provide sufficient additional clamping force to withstand the hydrostatic test pressure. More than this brings on a good chance of leakage, through "bowing" of the clamping plate.



Exaggerated sketch showing how too much torque tends to distort clamping plate and leads to leakage.

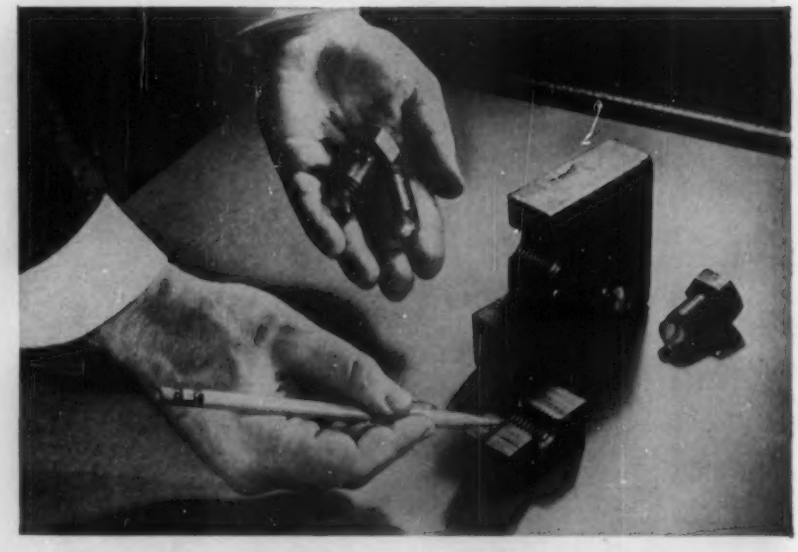
HYPOTHETICAL CASE

Suppose a joint is tightened with Grade 5 Hex Screws to their yield strength, and leakage develops. By going to alloy screws and tightening still further you would still get leakage. But Grade 2 Hex Screws, all torqued evenly, would no doubt solve it.

ACTUAL CASE

The fasteners on one product's flange had to withstand a 4000 pound hydrostatic pressure. But the hard asbestos gasket used took a bolt load of 28,000 pounds for sufficient compression to seal. By substituting a rubber and fibre gasket in this case, bolt load could be reduced. So could bolt size, thereby saving 73% on fasteners.

Using Hex Screws in tapped holes saves money



In the cast "coupon" shown above, the hex screws were torqued tight and removed 50 times—then torqued to failure. Note in the cutaway that the casting's threads are still perfect with no sign of stripping. It was the screws which broke—a clear demonstration that castings fastened with hex screws will suffer no thread damage during repeated disassemblies.

TWOFOLD BENEFIT

When there are no space clearance problems or other special requirements, using studs of 1-inch diameter or smaller often penalizes the user. First, in direct costs, since the more economical hex head screws will do the job to specification. And second, in production costs, since studs require that tapped holes have an *interference* thread fit, which in turn results in slow, "selective" assembly to determine properly mated threads. Hex screws need only a *clearance* fit, assemble faster.

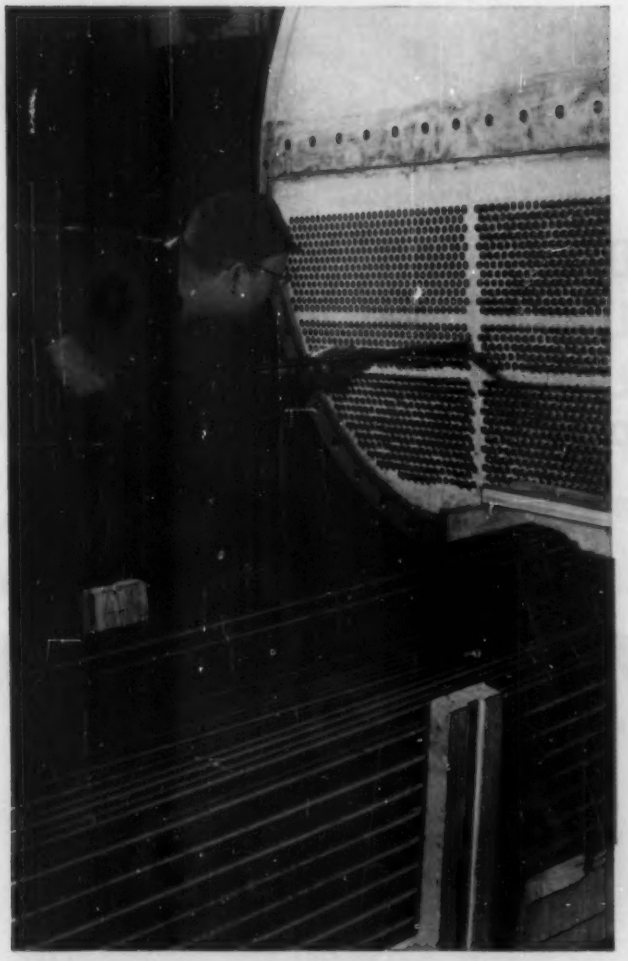
ACTUAL EXAMPLE

In one of his surveys of fastenings used by one company, the RB&W engineer pointed out that over 250 stud fastenings were being used in a large refrigeration unit. The same number of hex screws, costing $8.45, saved $22 over the studs and nuts. Annually, the total would be $7,800 on the production run of this unit.

Not to be overlooked either was the tangible saving on the less critical tapping job required.

RB&W offers its help on your specific fastener problems, or an overall survey of your fastener usage. Contact Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.



York counts on WOLVERINE TRUFIN® for Quality and Maximum Heat Transfer

In Atlanta, Ga., customers of Rich's Department Store shop in air conditioned comfort—thanks to air conditioning equipment manufactured by York Division of Borg-Warner Corporation, York, Pennsylvania.

And, like countless other air conditioning installations made each year by York, this one too, uses integrally finned Wolverine Trufin Type S/T condenser tubes in its heat exchangers.

Of Wolverine Trufin and its ability to increase heat transfer capacity, York engineers say, "Quality materials are as necessary as the skilled workmanship that goes into every York product. We find that Wolverine Trufin's extended surface gives us a good ratio of inside to outside heat transfer. It permits the maximum amount of heat transfer with a minimum of space while maintaining outstanding dependability."

If your company requires nonferrous tubing for heat transfer—or any other purpose—talk to Wolverine Tube before placing your next order. Like York Division you'll find the kind of quality and dependability that meets your highest expectations. Write, too, for your copy of the Wolverine Tubemanship Book.

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. B, 17278 SOUTHFIELD RD., ALLEN PARK, MICH.
Manufacturers of Quality-Controlled Tubing

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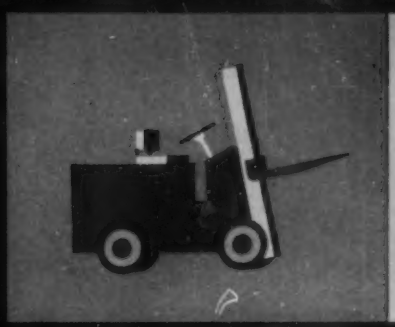
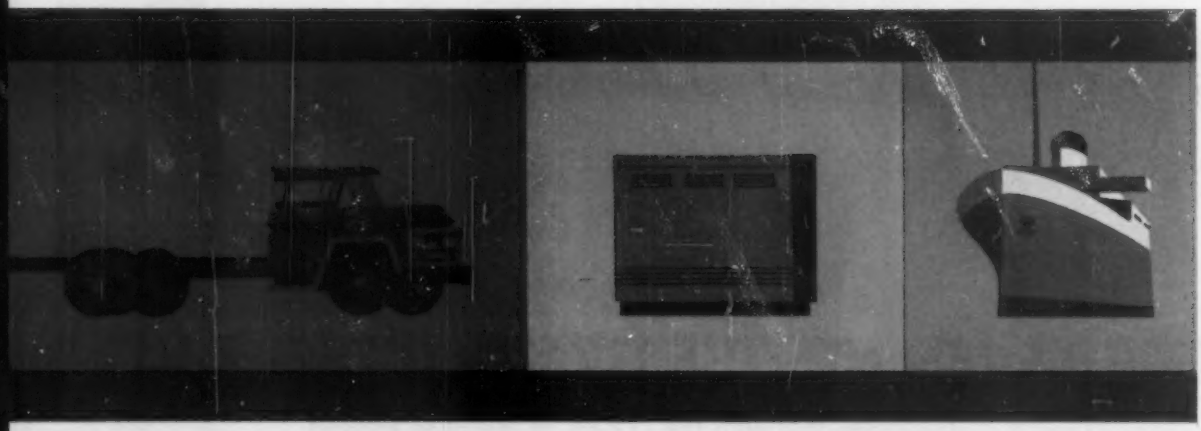
LESS WEIGHT AND
LONGER LIFE IN YOUR
PRODUCT WITH

N-A-X HIGH-TENSILE



STEEL



You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans and specifications. This versatile, corrosion-resisting, low-alloy, high-strength steel has many attractive features of special value to designers and manufacturers. For example:

- It is 50% stronger than mild carbon steel.
- It offers superior resistance to atmospheric corrosion.
- It has high fatigue life and great toughness.
- It has greater resistance to abrasion or wear.
- It has great paint adhesion, with less underfilm corrosion.
- It is readily welded by any process.
- It is stable against aging.
- It polishes to a high luster at minimum cost.
- It can be cold formed readily into difficult stampings.

With its many diversified applications in modern metal design, it will pay you to investigate N-A-X HIGH-TENSILE for savings in weight, in production time and for longer product life. A thoroughly competent metallurgical service organization is available to work with you on any application problem you may have. Write, wire or phone Product Development Department, Great Lakes Steel Corporation, Detroit 29, Michigan.

N-A-X
HIGH-TENSILE STEEL

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Detroit 29, Michigan

Great Lakes Steel is a Division of **NATIONAL STEEL CORPORATION**

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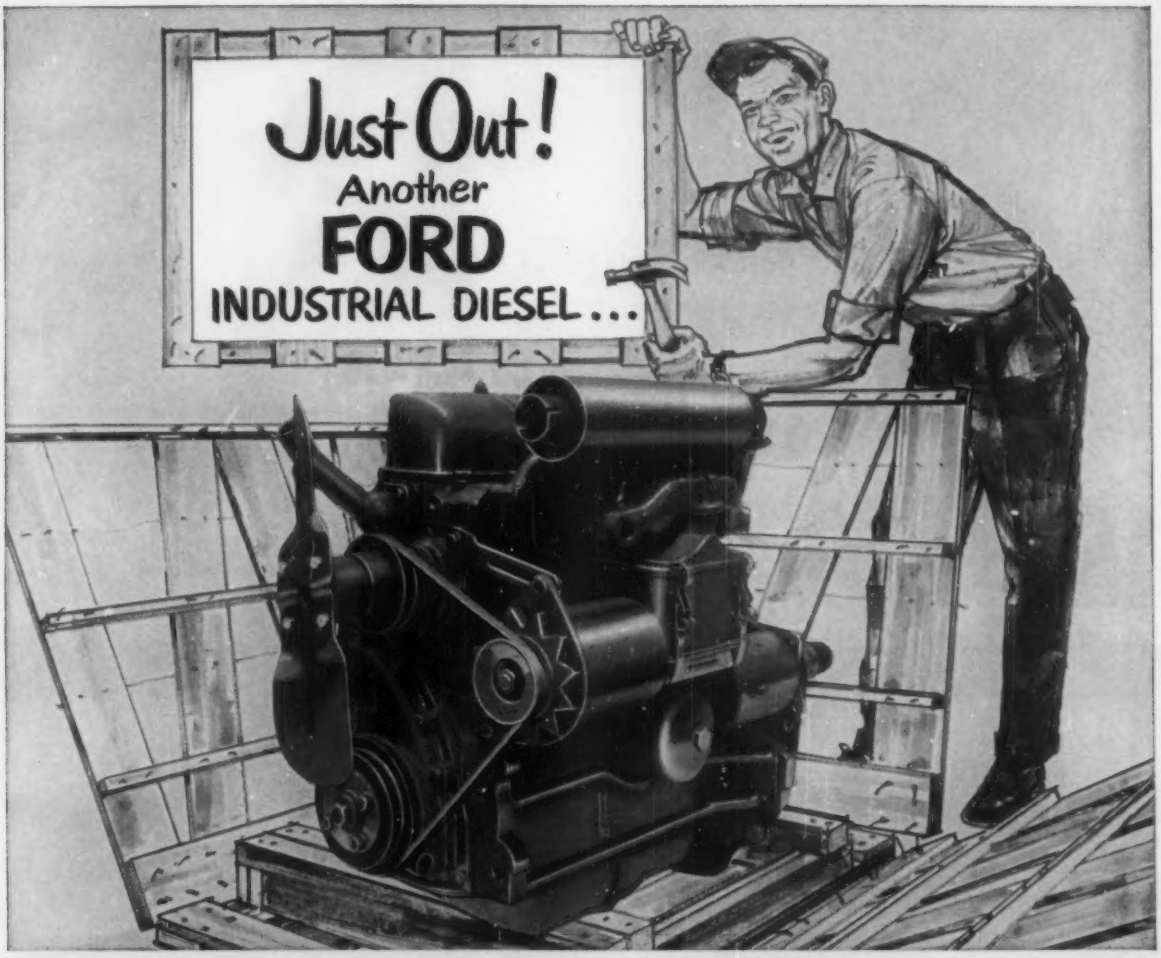

FORD PRESENTS THE 172 CUBIC INCH DIESEL FOUR!

(and it's interchangeable with the 172-cu. in. gasoline engine)

To meet the growing demand for diesel power, Ford now offers a choice of three economical diesels—the highly efficient 172-, 220- and 330-cubic inch models.

Whichever you select, you'll be getting a completely modern diesel that delivers the high torque necessary to handle tough jobs with outstanding operating economy and easy, low-cost maintenance.

Ford Diesels also offer dependable 12-volt electrical systems for quick starting . . . replaceable cylinder sleeves that eliminate costly reboring . . . and rotating exhaust valves for better seating, longer valve life.

What's more, Ford's 172 Diesel and 172 Gasoline engines are *interchangeable* in your equipment. Many *parts*, too, are interchangeable between these engines. And low-cost Ford parts and service are always available at any nearby Ford Power or Tractor Dealer.

For greater productivity and more profit in the long run, it will pay you to check the 172 model or other Ford Diesels at your Ford Industrial Products Headquarters.

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INDUSTRIAL ENGINES
AND POWER UNITS

ENGINE SERIES		172 FOUR DIESEL	220 FOUR DIESEL	330 SIX DIESEL
Basic Model		DD	X	Y
Type		4-Cyl. O.H. Valve	4-Cyl. Diesel	6-Cyl. Diesel
Bore and Stroke—Inches		3.9 x 3.6	3.94 x 4.52	3.94 x 4.52
Displacement—Cubic Inches		172	220	330
Brake Horsepower	Dynamometer	59 @ 2400	60 @ 2250	96 @ 2250
	80% Dyn. BHP	47 @ 2400	48 @ 2250	77 @ 2250
Torque	Dynamometer	140# @ 1200	151# @ 1600	236# @ 1600
	80% Dyn. BHP	112# @ 1200	121# @ 1600	189# @ 1600
Compression Ratio		16.5 to 1	16 to 1	16 to 1

INDUSTRIAL ENGINE DEPARTMENT, FORD DIVISION, FORD MOTOR CO., P.O. BOX 598, DEARBORN, MICH.

West of Rockies write to:
FORD INDUSTRIAL ENGINE DEPT., P.O. BOX 6787, LOS ANGELES 22, CALIF.
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ADVERTISEMENT

INTERNAL PRESSURE VS. EFFECTIVE SEALING

Internal pressure creates two forces which can cause leakage in a gasketed joint. Proper flange design and correct selection of gasket materials can overcome these forces.

E. M. SMOLEY,
Research Physicist
Armstrong Research and Development Center

The pressure of confined liquids or gases acts against a gasket in two ways, as shown in figure 1.

1. Hydrostatic end force. This is proportional to the internal pressure and

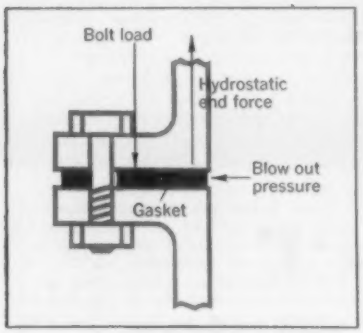


Figure 1. How internal pressure acts on a gasketed joint.

tends to move the flanges apart. As this occurs, the load on the gasket is reduced and leakage can result.

2. Blowout pressure. The sealed liquid or gas exerts direct pressure on

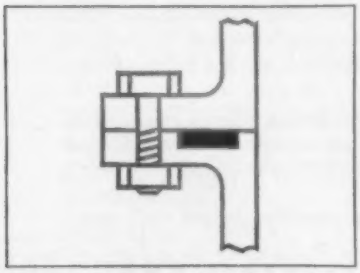


Figure 2. Flange design which confines gasket helps minimize blowout pressure.

the inside perimeter of the gasket. If this pressure is high enough, it will force the gasket out of the joint and leaks will occur.

These forces are usually associated with relatively high internal pressures. Studies at Armstrong Research and Development Center show, however, that pressures substantially less than 100 psi can cause leakage in some assemblies. (The Deflectometer shown in figure 3 is one tool used by Armstrong research engineers to measure flange deflection caused by internal pressure.)

Where internal pressures are involved, it is especially important to consider the joint as a unit. The flange design, the gasket material, and the temperature at the gasket line should all be considered in relation to each other.

The obvious first step is to be sure that flanges are sufficiently rigid to impose the required unit load on the gasket. The number of bolts, their size, their spacing, and their torque values are other factors related to flange loading which must be considered.

The second step is the evaluation of the gasket material to be used. High unit loads dictate the choice of a material that will not extrude or rupture under high pressures. This usually means a dense cellulose fiber or asbestos fiber material.

Several compositions suitable for service under high flange loads are available in the Armstrong Accopac line of beater-saturated gasket materials.

Where a compressible material such as cork-and-rubber is to be used, a flange design which confines the gasket,

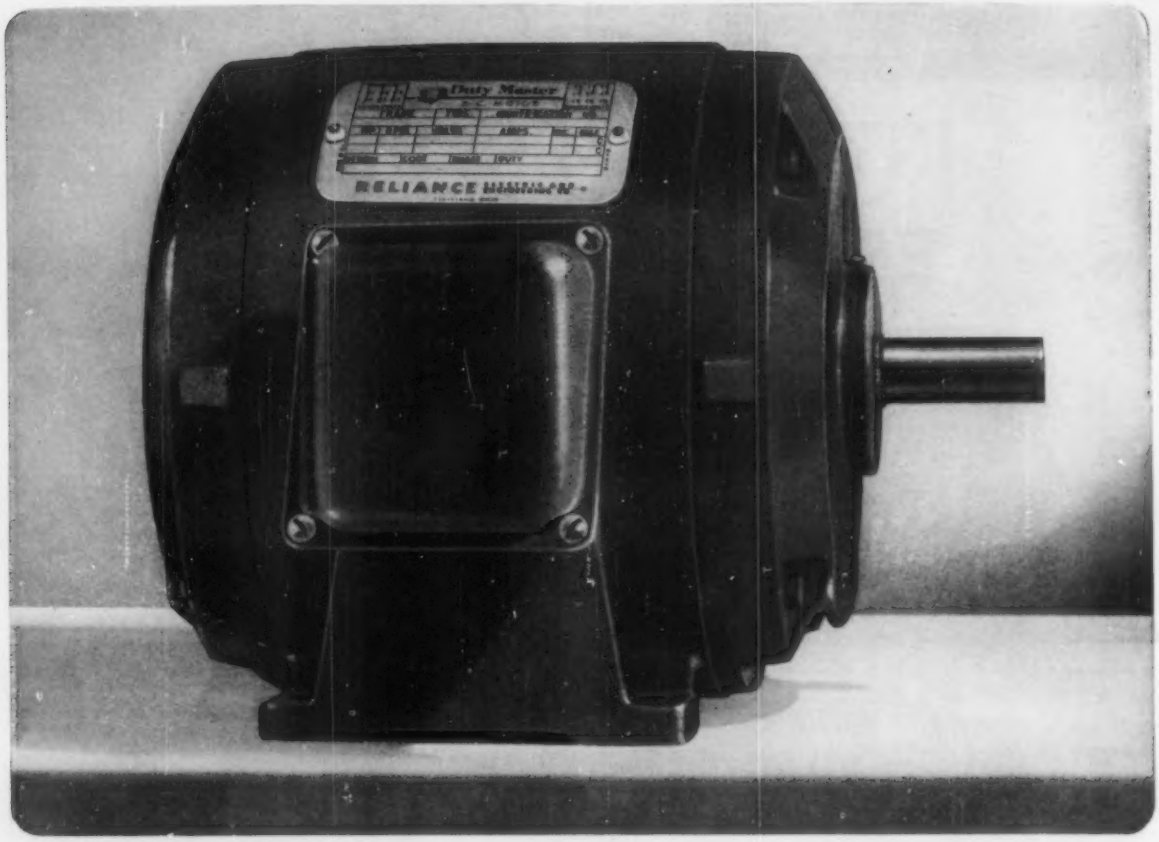
Figure 3. This Armstrong developed Deflectometer measures effect of 70 psi internal pressure in this stamped flange. Leak-producing deflections of .007" were detected at center point between bolts.

as in figure 2, will also help overcome blowout pressure.

A more complete discussion on the effect of internal pressure and other problems of gasket design, selection, and performance is included in the Armstrong Gasket Design Manual. Write today for your copy of this 32-page book. Address Armstrong Cork Company, Industrial Division, 7106 Ithaca Street, Lancaster, Pennsylvania.

Armstrong GASKET MATERIALS

1860–1960 Beginning our second century of progress



Duty Master

a brand new a-c. motor

Product of Reliance Electric and Engineering Company and its Master Electric Division, Duty Master's new design gives users better protection from the inside out, simplified lubrication, better response and improved all around performance. The Duty Master line, from protected-open, to totally-enclosed, explosion-proof, 1 to 250 hp., is ready for delivery *NOW*.

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Duty Master's low inertia rotor has faster response in starting, stopping and reversing. This plus better ventilation and increased accelerating torques, permits frequent starts and stops without over-heating.

Duty Master's new design proves conclusively that all a-c. motors are *not* alike . . . that this new motor gives users the best value in industry today.

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ANOTHER NEW PRODUCT OF

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BULLETIN SS-100

SCOTSEAL*

A new concept in oil seal design!

Integral sealing surface prevents major causes of leakage

It is now generally recognized that major causes of leakage among shaft type oil seals are: improper handling before assembly, damage by the assembler or shaft during installation, and improper shaft finish. Experts say surface finish of from 5 to 15 microinches is most desirable —but this is often prohibitively expensive.

The C/R SCOTSEAL precludes any possibility of damage by handling, installation, or shaft finish because the *sealing lip does not touch the shaft!* C/R's development of SCOTSEAL's integral, self-contained sealing surfaces assures you of reliable performance unsurpassed by the finest machined shaft surfaces.

HIGH PERFORMANCE OPERATION

Field tests have shown that this new C/R SCOTSEAL:

- SEALS WITH GREATER EFFICIENCY
- RUNS COOLER WITH LESS FRICTION
- DELIVERS GREATLY INCREASED SERVICE LIFE
- ELIMINATES SHAFT SCORING
- PREVENTS SEAL LIP DAMAGE AT ASSEMBLY
- REDUCES ASSEMBLY AND REPLACEMENT COSTS

UNIQUE DESIGN The C/R SCOTSEAL is designed and constructed to seal within itself. In effect it is a self-contained oil sealing cartridge. This sealing cartridge consists of two parts which have relative motion to each other. In the illustration above, the outer Unit (A) is an encasing member. A portion of the inner surface of this shell serves as the surface against which the sealing member runs. The inner unit (B) is the metal reinforced, bonded synthetic rubber sealing member. In the external design, illustrated, the sealing member pushfits over the shaft and becomes a part of it—actually moving *with* it—and the metal case or shell pressfits into the housing bore. On internal designs, the sealing surface pushfits on the shaft and the sealing member is contained in the shell which pressfits in the bore.

PRE-LUBRICATED Since the sealing element is enclosed, prelubricant applied during fabrication stays in place and lubrication is supplied to the sealing lip through centrifugal action, giving extra protection particularly during starved conditions. Where the seal will be exposed to considerable dirt and water, a dirt lip is provided. Also, drain holes can be provided in the shell adjacent to the dirt lip. Centrifugal force will then sling dirt and water out . . . keeping the C/R SCOTSEAL as free as possible from abrasive elements.

ECONOMICAL Significant savings or cost reductions can be realized with the C/R SCOTSEAL. Where normal lip-type seals ideally require a shaft surface finish of 5 to 15 microinches and minimum hardness of Rockwell C30, no special finish or hardness is required for the SCOTSEAL. Shafts need not be specially hardened, ground and polished over the area where the seal contacts the shaft. Nor are wear sleeves shrink-fitted on the shaft required. All of these operations are eliminated when the C/R SCOTSEAL is used. The savings in machining costs alone will more than offset the slightly higher first cost of the seal. And there is no possibility of lip damage in installation. Additional dependability and quality will accrue to your assembly in the minds of the end-user. There will be no scored shafts to remove and refinish. Replacement of the SCOTSEAL, if necessary, is a quick, simple procedure. Thus, equipment downtime and maintenance costs will be reduced.

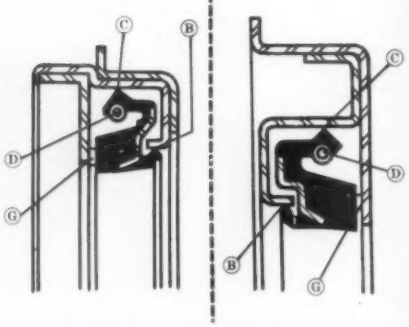
APPLICATION The C/R SCOTSEAL is currently providing increased sealing efficiency and extended service life on truck, bus and trailer axles. Its advantages indicate application wherever a high production run is involved; where oil retention is difficult; and where equipment downtime and replacement costs are critical. In broad terms, the SCOTSEAL may be used wherever an oil-tight press is possible.

(SEE ILLUSTRATIONS ON OTHER SIDE)

* Self Contained Omnipurpose Type SEAL. Trade Mark

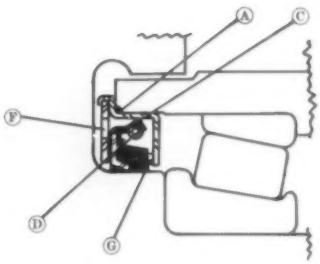
Shaft Type Scotseals...

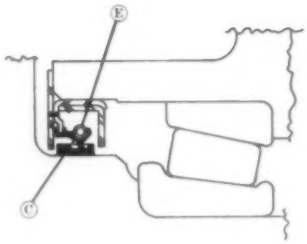
The versatility of the basic C/R SCOTSEAL concept is illustrated below. Note the many different configurations, as well as material combinations, that can be developed, all embodying the self-contained principle, but fitting ideally the requirements of various applications.

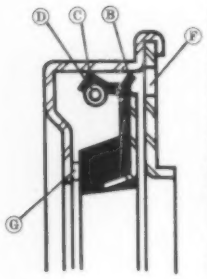


External Type SCOTSEALS

TYPICAL INSTALLATIONS...SEALING BEARINGS







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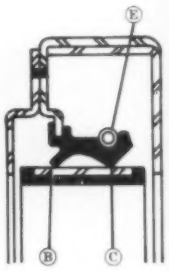

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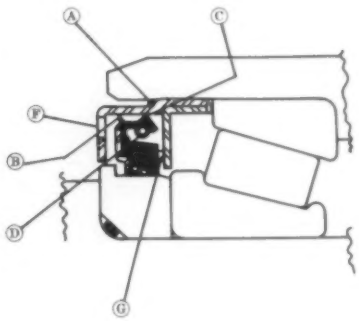

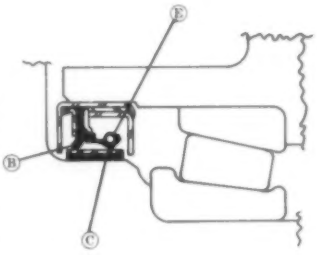

LEGEND: **(a)** Sirvene Gasket **(b)** Dirt Lip **(c)** Sealing Lip **(d)** Expanding Spring **(e)** Contracting Spring **(f)** Drain Hole **(g)** Chaplets—keep sealing element spaced axially within its shell to insure proper installation.

Investigate this seal further. It will reduce costs for you and the ultimate user of your equipment where large production quantities are involved, and leakage, downtime and replacement are critical factors. C/R Oil Seal engineers will gladly recommend the correct C/R SCOTSEAL design for your application. Get in touch today.

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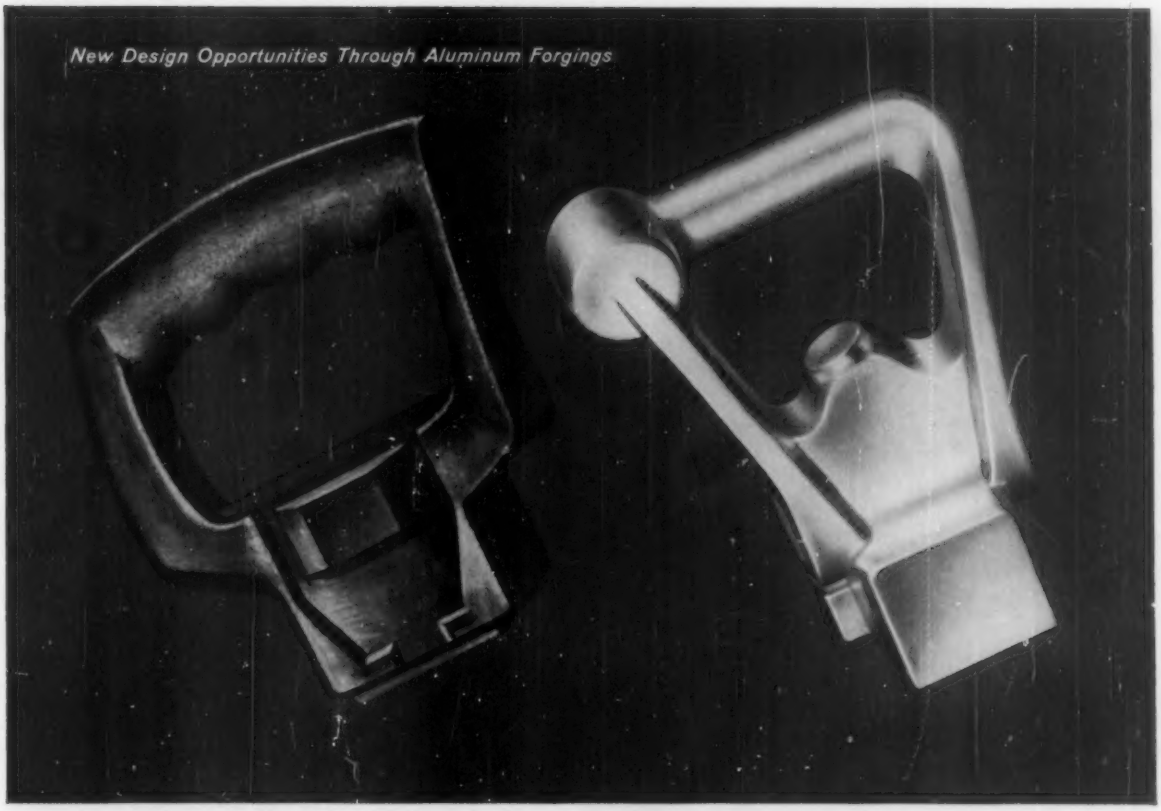

WHICH DRILL HANDLE HAS THE WEIGHT ADVANTAGE?

The handle on the right . . . because it's aluminum! This forged aluminum drill handle is a good example of how aluminum forgings are solving difficult design problems involving light, strong tool parts.

Previously, the handle was fabricated as an iron casting . . . and iron castings are *heavy*, as workmen using the drill soon found out. To lighten the worker's load, a search began for a new design that would reduce the weight of the handle, yet retain its strength.

Solution: the aluminum forging shown in the picture. It weighs only one-third as much as the old cast iron handle. Yet, due to the forging process, its strength is even greater. Grain flow lines of the metal follow the contour of the part, concentrate at points of greatest stress and shock to give the handle amazing strength.

This highly favorable strength-to-weight ratio is one reason why so many designers are turning to aluminum forgings for more and more commercial applications. Find out how aluminum forgings can best serve your requirements. We'll be glad to send you full details on aluminum forging availabilities, tolerances and hand forging designs—just mail the coupon!

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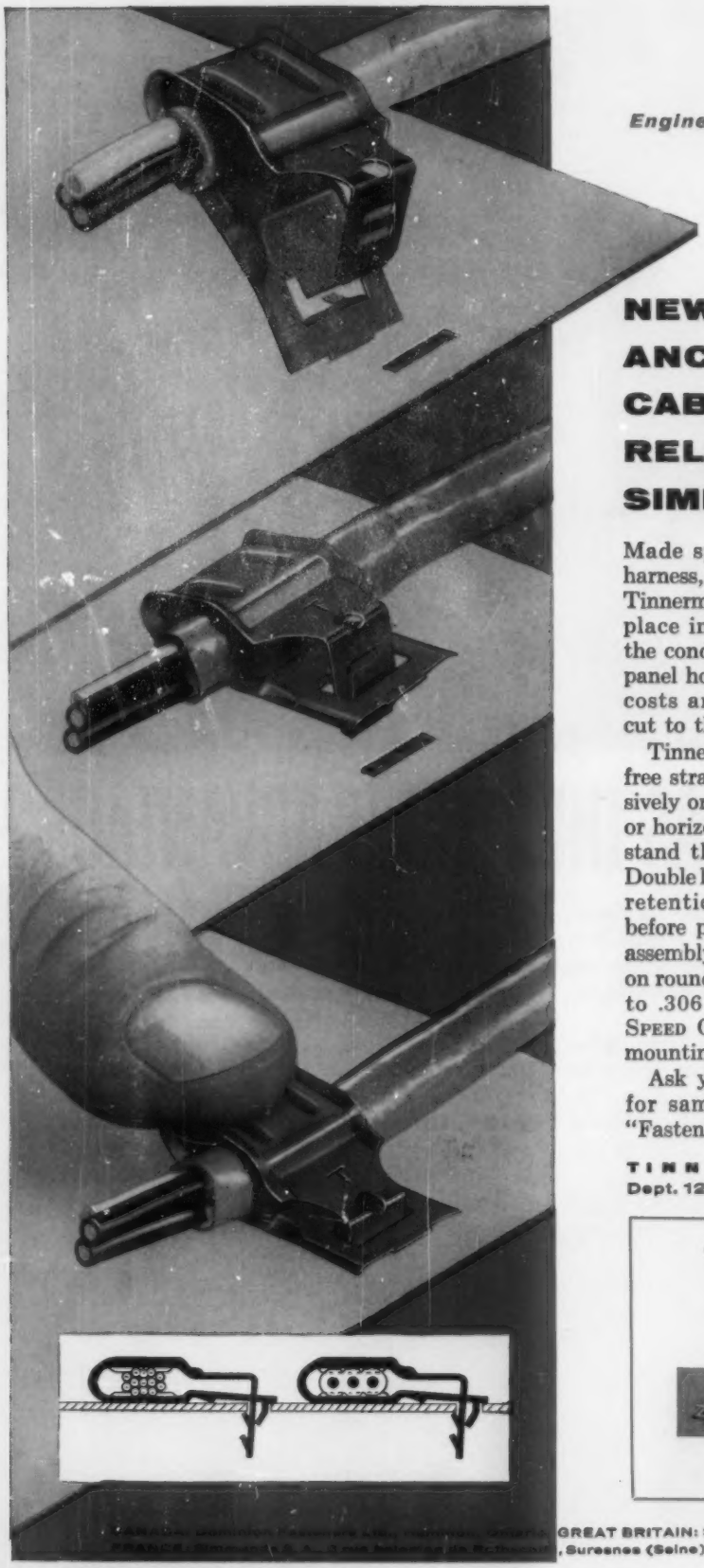

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NEW SPEED CLIP® ANCHORS WIRES, CABLES, TUBING, RELIEVES STRAIN, SIMPLIFIES ASSEMBLY

Made specifically to attach cables, wires, harness, or tubing firmly to panels, this newest Tinnerman SPEED CLIP is readily snapped into place in only 3 simple steps. Prelatch it on the conductor or tubing, insert SPEED CLIP in panel hole, then push home to lock. Assembly costs are reduced because assembly time is cut to the minimum.

Tinnerman SPEED CLIPS also serve as trouble-free strain-relief clamps—they are used extensively on appliances for attaching 3-wire round or horizontal section rib cord, and easily withstand the 35-pound pull test requirements. Double latch permits pre-assembly and accurate retention of SPEED CLIPS to wire or harness before panel assembly for further savings in assembly time. Double-rib retainers grip tightly on round or rectangular cords from .175" round to .306 x .515" rectangle. Important, too, SPEED CLIPS can easily be removed from the mounting side.

Ask your Tinnerman sales representative for samples and prices. He's listed under "Fasteners" in most Yellow Pages. Or write to:

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PRODUCT ENGINEERING HORIZONS

June 20, 1960

WHO'S THE HERO?

All of us have been taught that the turbine is descended from the aeolipile, invented by Hero of Alexandria in the third century. But there are those who are convinced that the real inventor was Ctesibus, four hundred years earlier. Hero was just the man who first talked about it.

You'll find that Darwin almost lost credit for his theory because he spent a dozen years toying with it—until someone else came up with the same idea. The conflict between Popov and Marconi on the invention of radio has similar overtones—but Marconi made it work, and talked about it to other than his cronies.

Every branch of history is replete with similar examples: Who were the two men who stood with Horatius at the bridge? Who carried the message to Garcia? Who hung the lantern for Paul Revere? Did Pershing really say, "Lafayette, we are here"?

In each case, we remember the event because somebody told about it—to people generally. What's more, we remember it *as he told it*, not as it really happened. We even remember things that never happened—the apple archery of William Tell, the Washington cherry tree, the wreck of the Hesperus on the Reef of the Norman's Woe, the good news carried from Ghent to Aix—because *somebody told a story convincingly*.

The point is simply that it is not enough to do something—you must also be able to tell about it, or to find someone who can. This point is not sufficiently made in our engineering colleges, and it tends to be contrary to the feelings of the inventive person. He assumes that telling is immodest and unnecessary. He feels that his achievements will be recognized, that his ideas will be understood, that credit will be given by others.

Chances are that they won't be—unless the engineer does something about it. The great advantage that man has over the lower orders of animals is that he can communicate—if he will—other things than danger signals and love calls. And communicate them he must, if his work or his deed is to be remembered. The images we have of men and their deeds is precisely what has been told and retold. Historians can't understand where we get our images of George Washington and Abraham Lincoln, Anthony Wayne and Benedict Arnold. Engineers have been having difficulty understanding why every missile is built and fired by a scientist. The thought that the fault is their own never enters their minds.

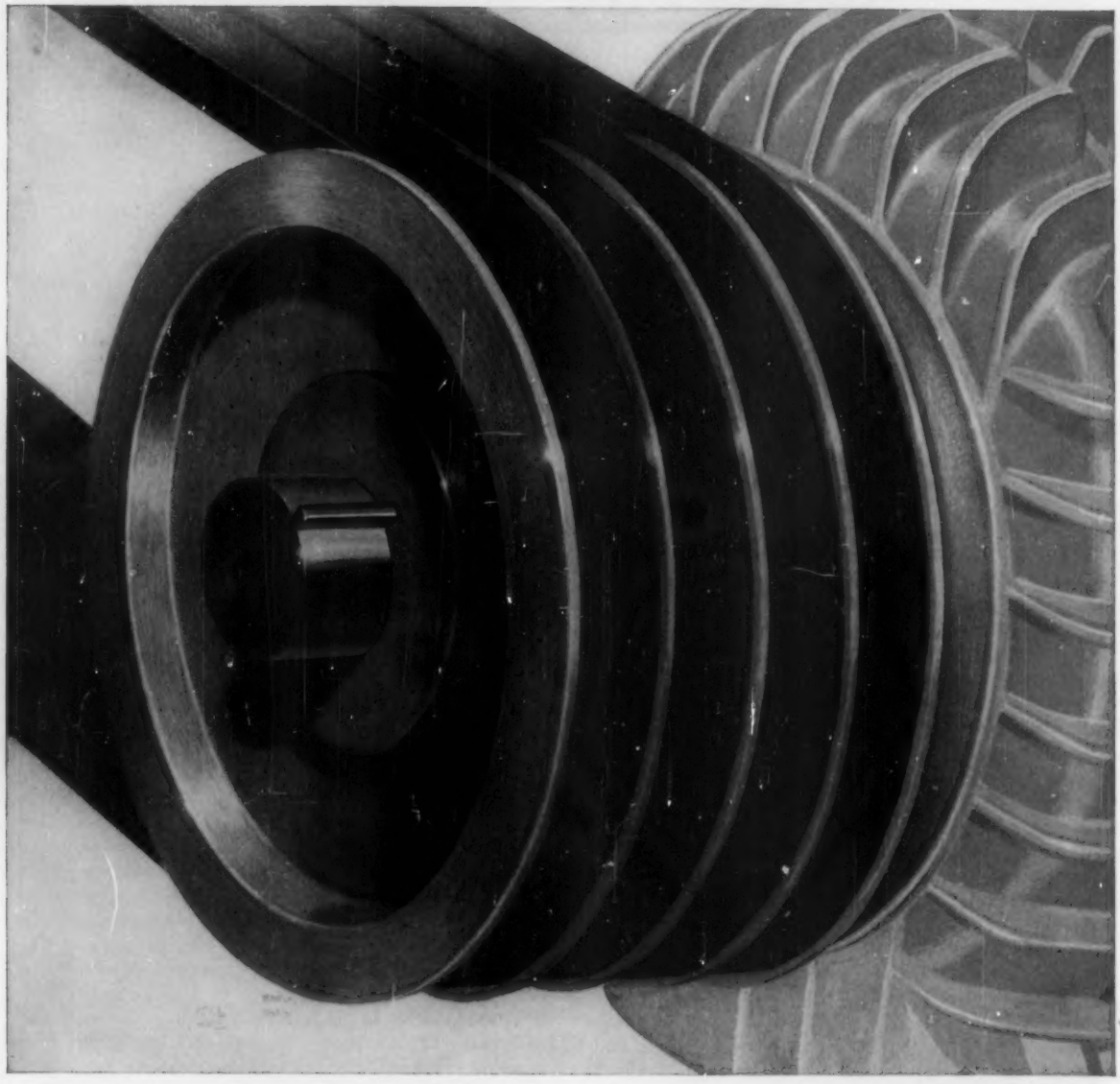
The basic fact is that a knowledge of the ABC's and a smattering of high-school grammar with an overlay of technical words will not communicate ideas. Clear, lucid reporting in familiar words, with occasional points of interest and good organization of thought, will do it. Good reporting is a matter of some training but more so of considerable practice.

More than 20,000 of you have asked for reprints of our series of articles on writing. This shows recognition of the problem and a willingness to correct it. The articles provide the rudiments, but they will serve no purpose if you don't study and apply them—aspirin that stays in the bottle eases no headaches. A recent study shows that the number of papers produced by candidates for doctorates drops off to the vanishing point after the degree is granted—only a few degree holders continue to report their work. And holders of lesser degrees do much less. We on *Product Engineering* find this the primary problem in obtaining authored articles—"no time to write."

That means no time to communicate, no time to convey ideas, no time to tell a large engineering audience what you're doing, no time to establish and maintain a professional position.

It may mean that Hero becomes the hero, although Ctesibus does the work.

Get up to 300% greater horsepower per belt!



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For the next drive you install, be sure you specify super-rated V-belts reinforced with tough, long-wearing Du Pont "Dacron". Du Pont makes the "Dacron" fiber used by belt manufacturers in producing their finest-quality V-belts.

FREE BOOKLET: "Du Pont 'Dacron' Sets New Standards for V-Belt Performance". Write: E. I. du Pont de Nemours & Co. (Inc.), 31E Centre Road Bldg., Textile Fibers Department, Wilmington 98, Delaware.

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PRODUCT ENGINEERING

SPECIAL REPORT

YOU and your employer

In recognition of your growing status in today's society, companies have reacted, not only with increased salary levels, but with more and more of the so-called "fringe benefits." They ask for nothing more in return—only the best of your professional talents, and rights to ideas developed on company time or as a result of company know-how.

Most engineers agree the exchange is a fair one. But many would prefer some additional benefits. They would like more recognition or more opportunity to exploit their creative abilities. On the following pages are the results of two surveys sponsored by PRODUCT ENGINEERING. They examine the employer-employee relationship at close range from these viewpoints:

Nonfinancial requirements—what do engineers want? *Robert C May, Automatic Switch Co.* . p 60

Fringe benefits—what do employers offer? *A staff survey* . . . . . p 61

That patent agreement—should you sign? *Floyd H Crews, Darby and Darby, Attnys* . . . . p 62

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engineers cite realistic nonfinancial requirements

Status symbols are for the class-conscious; engineers want benefits that are more practical—facilities and company policies that help them do their job more effectively. Most can be provided at very little company expense.

ROBERT C MAY, *sales promotion director, Automatic Switch Co*

■ Before accepting your present job you probably weighed many factors—salary, challenging work, opportunity for advancement, security, location. Today you know that the satisfaction you get from your job hinges on other matters as well. The nonfinancial benefits provided by your employer may seem to have only minor importance, but in the aggregate they can make a big difference in your enthusiasm and in your ability to turn out your best work. Which of these job prerequisites do engineers consider most important? To find out, we mailed a questionnaire to several hundred engineers and asked them to indicate which of 18 selected minor benefits were either "important," "nice, but unnecessary" or "not needed." The respondents were most reasonable in their requests. They showed little interest in those factors that make the job seem more important, and concentrated on benefits that assist them in the execution of their duties.

Question sheets were returned by 172. Most respondents were design engineers with titles ranging from Mechanical Designer to Chief Engineer. They covered a broad range of industrial activity and their companies varied in size from the smallest to the largest: the answers represent a well-balanced cross-section of opinion.

It was considered impractical, however, to eliminate two factors that may have had some influence on the results. First, what a man thinks he needs will depend somewhat on what is, and is not, already provided. Although asked to weigh the elements impartially, he is only human when he emphasizes those factors that are most annoying by their absence. Also, requirements for certain benefits (a private office, a personal secretary) will depend on a man's position in the company. This factor was minimized, however, by maintaining a well-balanced distribution of titles from the lowest to the highest.

Intracompany Communications Necessary

Of all items listed, the need considered most important by all engineers was the opportunity to present ideas to top management and to be advised of company plans. Less than 4% felt this was not an important factor. Although this does not necessarily indicate that the communication links between middle and top management are weak, it points to a critical area where all companies, particularly large ones, should maintain constant vigilance. Opportunity to mix socially with the top brass, however, was not rated very important. One vice-president summarized it this way, "Those engineers who can make the transition to the executive division are capable of going all the way to the top without a social assist."

Among the tangible benefits a private telephone was voted most important (70%) although one engineer probably voiced the feelings of many when he wrote "I wish I didn't have one." For the most part, respondents felt that a partitioned office, two engineers per room, was most desirable (or perhaps most practical). "More than two per room," commented one, "is intolerable. The phone rings constantly and there is always confusion."

A few items were added to the questionnaire by respondents who felt that the list ignored some important benefits. "Flexible starting and quitting time," was suggested by one, for example, while another pointed to "overtime or extended time policy," and "longer vacations." Environmental factors such as air conditioning, ventilation, low noise level, cleanliness and lighting, were written-in two

or three times, as was "adequate space for work, files and meetings." A company library, conference rooms and reserved parking spaces rated mentions by several engineers.

Response to questions relating to need for technicians and secretaries indicates that most engineers are easily satisfied, will settle for only a minimum of supporting personnel. A pool of departmental technicians and departmental secretaries is all that is necessary in most cases. One respondent: "I need a pool of draftsmen and technicians for noncreative work to save my time for design problems."

Except for those benefits that cost nothing to provide (unrestricted flow of information, for example) the large company apparently has some advantages over the smaller firm. A chief engineer from a 250-employe company commented wistfully, "Large companies can afford such niceties. Our graduate engineers have no private offices, no partitions, no secretary (either departmental or private), no titles, no business cards, and none of the other tangible items except opportunity for paid advance study." ■

HOW ENGINEERS RANK NONFINANCIAL BENEFITS

	Response, percent			
	Important	Nice but unnecessary	Don't need it	No answer
Intangibles				
Opportunity to present ideas to top management	85	11.5	1	2.5
Being advised of company plans	70	8	2	20
Freedom to attend society meetings on company time	69	27.5	3.5	0
Opportunity to obtain advanced degree	57	31	7.5	4.5
A title	57	17.5	11.5	14
Chance to speak at sales and technical meetings	56	25	14	5
Encouragement in writing articles and papers	49	34	13.5	3.5
Opportunity to mix socially with top brass	17	60	23	0
Tangibles				
Private telephone	70	20	10	0
Business cards	54	27	17	2
Partitioned office	50	28.5	9	12.5
Private office	33.5	44	17.5	5
Key to plant door	29	25.5	42	3.5
Executive-type furniture	11	51	33	5
Personnel Requirements				
Departmental secretaries	69	10.5	8	12.5
Departmental technicians	67	11.5	11	10.5
Personal secretary	22.5	37	29.5	11
Personal technician	17	29.5	33	20.5

personnel policies are not uniform, but differences are small

A Product Engineering Survey

Is the engineer treated with the professional respect he so often cries for? This survey shows that most large corporations have adopted liberal policies with regard to vacations, fringe benefits, time clocks.

■ Early this year, PRODUCT ENGINEERING sent a questionnaire to a selected group of large corporations—specifically those hiring many mechanical engineers in design and development areas. The survey asked 5 questions about the company's personnel policies as they apply to design engineers; 54 companies responded. Here are the questions and the companies' answers.

1. Do your engineers punch a time clock or fill out time cards?

Most companies claim time clocks are only for those employes paid on an hourly basis. In some companies graduate engineers at the lower levels are not salaried and therefore punch a clock. But only 7 companies require salaried employes to use a clock. Some of these have a union, others require clocks only for junior-level engineers. In 2 companies, everyone punches a clock.

On the other hand, there is usually some arrangement for keeping track of how much time (on either a daily or a weekly basis) was spent on which project, particularly at those firms working on government contracts. But a number of companies have no system of time cards whatever.

THE SCORE: Time clocks—Yes, 19%; No, 81%
Time cards—Yes, 74%; No, 26%

2. Do your engineers sign an employment contract? A patent agreement?

Only 6 companies indicate that an employment contract is required, but half of these limit it to top-echelon jobs, or in cases where relocation is being paid by the company.

Most corporations, on the other hand, require the engineer to sign a patent agreement.

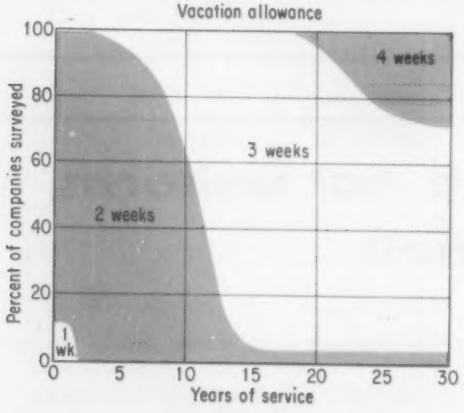
THE SCORE: **Employment contract–Yes, 6%; No, 88%; In Some Cases, 6%**
Patent agreement–Yes, 96%; No, 4%

3. How much time is allowed for sick leave, vacation?

With salaried engineering personnel, 1- or 2-day absences for sickness are almost always handled individually, apparently on the premise that getting the job done is more important than mere attendance at the plant. Extended sick leave for hospitalization is usually controlled by a more rigid policy although, even here, continued, full-salary periods are somewhat at the discretion of the supervisor. Therefore not all companies answered this question. Those answering often failed to make a clear distinction between allowance for excused absence and allowance for hospitalization. As a company policy, hospitalization periods vary from 2 weeks to 3 months; allowable absences from 5 to 7 days per year.

All companies observe at least 6 paid holidays; however, most regularly include two additional days such as Washington's Birthday, Lincoln's Birthday, Election Day, etc.

The most variation among corporation personnel policies is in vacation time. The vacation allowance, as a function of length of service, is summarized in the chart below.



4. What other fringe benefits are provided?

Most all companies offer retirement, insurance and hospitalization benefits; these are standard. About half the companies pay all or part of education expenses for study in areas related to the employe's work. Only a small number of companies (about 5%) have either a profit-sharing plan or stock-purchase agreement.

5. Must an employe have a degree in engineering to have "engineer" in his title?

For the most part, no. Only 5 companies answering this question gave an unqualified yes. Others implied there was no established policy on the matter by such answers as "yes, or equivalent experience" or "not necessarily, but most engineering positions require a degree," and similar equivocations.

THE SCORE: **Yes, 9%; No, 48%; Not necessarily, 43%**

that patent

FLOYD H CREWS, *attorney*
Darby & Darby, New York City

■ It's a rare company, these days, that doesn't have a patent agreement waiting for your signature when you start to work (only 4% according to the survey cited in the preceding section). And very few engineers refuse to sign. If you had any hesitation about whether to sign your brains away, you should take a closer look at what your contractual responsibilities are and what the company is aiming to protect when it asks you to sign.

Despite the legal verbiage, patent agreements are only very simple cont. .ts. After a study of 36 documents supplied by large corporations, it appears that most agreements are similar in their demands. Except for one major provision all say about the same thing. Some are broader in scope than others; some go into more detail; but all call for (1) disclosure of inventions, (2) assignment of inventions, (3) assistance in getting and enforcing patents on inventions, and (4) maintaining company secrets.

To the engineer, the most important difference among contracts is the clause that defines the period during which inventions are to be assigned to the employer. In most cases the agreement does not bind the engineer after termination of employment. But in 7 of the 36 contracts, this assignment period is extended for a short term following employment.

The Detail Differences

All the patent agreements studied require disclosure and assignment of inventions relating to the company business. Some add prospective business. Some add any field the company is investigating. Some add all inventions of whatever nature made during working hours or on company time or with the company materials. All but two expressly include foreign patents, but those two also include foreign patents by implication. This requirement to assign all inventions and patents to the employer is the most

agreement—should you sign?

The answer is simple: If you want the job you have no choice. But, with few exceptions, such contracts are a fair and reasonable condition of employment. They may hamper you some, but your company has a position to defend too.

important part of the agreement for both parties.

As for your assistance in helping the company obtain a patent, some require execution of all necessary documents and the majority require the performance of all proper acts. Most specify that the acts will be performed both during and after termination of employment. This presents no problem to the engineer. Such a requirement is implied in an agreement to assign, but an express agreement is sometimes helpful to the company in case of trouble.

Surprisingly, 19 contain no provision for secrecy. The rest prohibit disclosure of secrets at any time, except for one contract binding the employe to maintain secrecy for only 3 years after separation. A few include a provision that no company records, notebooks, or drawings be removed on termination of employment. These requirements are reasonable; no one can object to agreeing to be honest.

Twenty-six forms require the employe to list prior inventions which should be excluded. This should be standard. It protects the employe in case he has overlooked reserving previous inventions and protects the employer from possible disputes.

For the most part, then, differences are a matter of form rather than substance. The shortest contract contains 152 words but the majority are much longer, some running to thousands of words. This prolixity only serves to increase printing expense, bewilderment, and confusion. The short ones say the same thing; they're just more simple, more direct, and more easily understood.

One Major Exception

Of the 7 contracts with extended term of assignment, 2 extend it for three months, 3 for six months and 2 for one year. Such extensions are of doubtful legality and, for this reason alone, are poor company policy. Also, I think they breed bad morale. A man may sign, but carry a lingering suspicion that he has been captured, and an active resentment of unfairness. If he wants to look for a new job, he has lost some of his bargaining power because his previous employer can claim an invention made on the new employer's time. (No contracts permit assignment of inventions to a former employer for the first months of a new job.)

Don't sign such a contract. The few companies that follow the practice will soon drop it if it hampers their recruitment. In the meantime you can find a job elsewhere.

Except for these 7 there is really very little to choose among the rest. I am sure that most men could work out their lives without remembering what they had signed and without it ever making any difference in their actions or those of the company. A marriage can be happy, whatever the form of the ceremony.

But I see no need—and no reason—for the verbiage. A simple form could say the same thing and say it better. A suggested form, copied almost directly from one of those submitted, is:

> "In consideration of my employment and continued employment by the X Company, and the salary to be paid, I agree:
>
> "1. That I will fully disclose to the Company any and all inventions conceived, discovered or made by me along the lines of the Company's work, investigations or interests while in its employ.
>
> "2. I will and do hereby assign to the Company all such inventions and any and all patents thereon.
>
> "3. I will fully cooperate with the Company in securing and enforcing Letters Patents for said inventions everywhere, and I will execute all proper

papers and documents and do all proper acts to enable the Company to secure patent protection and enforce the patents in all countries, at the Company's request and at its expense, both during my employment and thereafter.

"4. I will preserve in confidence all of the Company's secret and confidential matters both during my employment and thereafter.

"5. As a matter of record, the following ..... pages contain a complete list and description of all inventions which I have heretofore made and which are excluded from this Agreement."

If this is what the inventor's contract says, should you sign? Of course you don't have to. There are plenty of job opportunities without signing. Thousands of engineers (or perhaps tens or hundreds of thousands) have never signed an inventor's contract. Most of them earn their living by teaching, consulting, independent inventing, or a business of their own. You do have a choice.

But the fundamental question is not whether there are other possibilities, but whether such a contract is fair as a condition of employment.

I think it is.

The Company Position

Consider, for example, what a rare and unusual thing an invention is. At the present rate, if all inventions made in this country were made by engineers, each engineer would contribute only about one invention in 10 years or so. Since all inventions are not made by engineers the rate is obviously something less than this. Even in a first-rate organization such as Bell Telephone Laboratories, where many creative men grapple with rewarding problems, the rate is only about one invention per engineer in 10 years. An invention is still a rare and unusual thing even in that organization.

Consider also the expense of an invention. Some research projects fail. A director of research recently told me he thought his company was doing well if one project in a hundred paid off. The good ones must pay for the bad ones. No one can predict the winner. The product may incorporate the best inventive genius and the best engineering and still fail.

Furthermore, it's a long and expensive step from the invention to a profitable business based on that invention. The cost of getting it on the market can easily exceed the cost of finding and developing the ideas. In the case of nylon, DuPont invested some $45 million before getting any return. In the case of color television, RCA has invested something over $100 million and is still waiting for its profits.

What Would You Do?

Let's approach the matter from a different angle. Suppose you, an engineer, exercise your choice not to sign, and decide to start your own business. You have an idea for a new product that you want to build and sell. It's a good idea and you are able to get capital for your product to the extent of half a million dollars. You estimate that it will cost that to develop the idea and get it on the market. And to do so will require 20 man-years of engineering.

Having a bias against inventor's contracts, you do not ask your engineers to sign, and even go so far as to inform them that any inventions they make will be their own. Your product requires topnotch engineering and you hire the best engineers you can find. For the 20 man-years you can reasonably expect a couple of patentable inventions and may get more. What happens when you put your product on the market?

Remember, you have no patents.

In the first place you will promptly have competitors and they will profit from your development. Where it cost you $500,000 to get on the market, your competitors will be there at $50,000. They can sell at a price you cannot meet. You have no redress because you have lost your only protection—your patents.

The engineers who designed your product hold the patents. As soon as your product hits the market they can sue you for infringement and get an injunction prohibiting further manufacture.

Your engineers may, of course, offer you a license. They may also offer licenses to your competitors. But you cannot afford to pay the same rate of royalty as your competitors because of your greater development expenses. You simply have to face it. You have lost your shirt and betrayed your backers.

So, like it or not, you, as employer, cannot hope to stay in business without some form of inventor's contract. And the same applies to a company that has been in business a long time. The patent system promotes new-product development because it provides means for recouping the unusual expenses incurred by a pioneer. With it, a man (or company) can afford to spend five years working on an invention because others are temporarily excluded from the market.

Some engineers refuse to sign because they feel that the effect is to spread the fruits of their inventiveness over the whole company and thus reward inventive and noninventive alike. These persons, however, can always exercise their choice to go into business for themselves. Very few do. Apparently they are unwilling to risk supporting themselves and their family on that average of one invention every 10 years. The industrial team that they deplore is not a hindrance; it gives security without having to rely on personal output.

Perhaps we should remember that one of the great inventions—one that was never patented—is the corporation itself. It is the corporate form of business, which can provide the supporting cast—financing, administration, production, marketing—for the engineer's research. It takes the burden of self-support off his shoulders. He does not work for nothing while waiting for his first invention. He does not lose money when the invention fails. He may never even make an invention, but still earn his money because without him, the inventive engineers would not have had time to invent. If he succeeds with a marketable invention the reward is cut down, but without the supporting cast it would be zero.

With an inventor's contract, then, the engineer can join the team. Under this arrangement he gets financial stability, time, facilities, and a supporting cast. Without it he is forced to flounder on his own.

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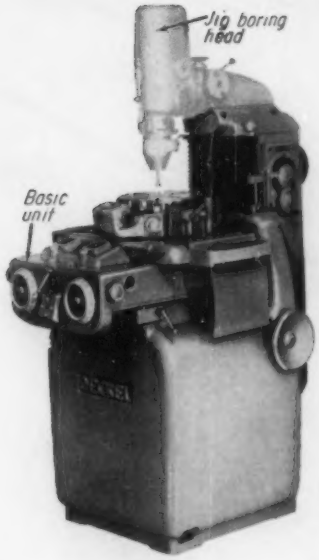
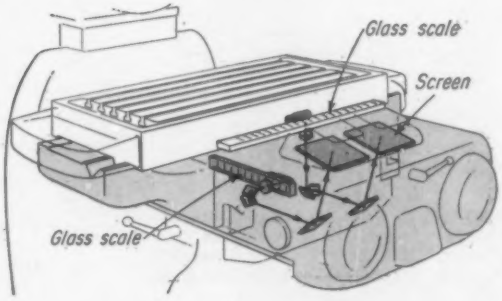
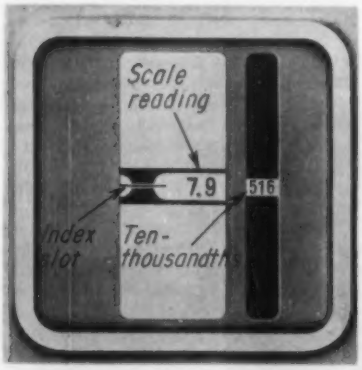


Transparent Scales Guide Worktable Accurately

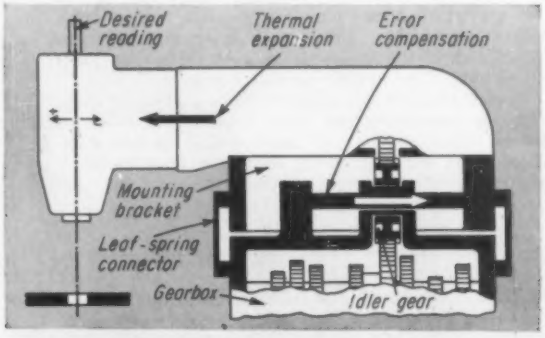
Optical measuring system for machine tool gives quick positioning, allows tolerance limits as low as ±0.000,02 in. Base unit can be combined with different heads to construct a jig borer, jig grinder or measuring machine. Compensating mount eliminates thermal-expansion errors.

TWO GLASS SCALES, one mounted on the saddle and the other on the cross-slide, indicate the position of the worktable. Light shining through these scales is projected onto two screens at the front of the machine, giving readings to the nearest tenth of an inch. Operator first uses fine-adjustment knob to select the last three digits desired (516 in this case). Then he uses rapid traverse and fine-adjustment wheel to center index line corresponding to the first two digits (7.9) in the slot at left. Worktable is now at the required position in this direction. A similar procedure is followed to set the other coordinate.





PS . . . Optical system for positioning cross-slide and saddle is enclosed in base. Other components such as borer, grinder or coordinate projector are fitted to the mounting bracket. Optical-Coordinate Jig Borer LKB, Jig Grinder LKS and Measuring Machine LKM are produced by Friedrich Deckel, Munich, W Germany.

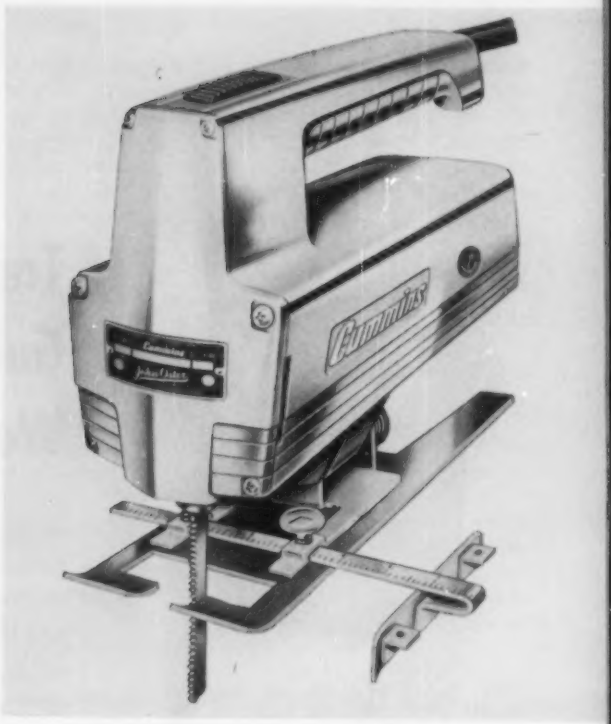


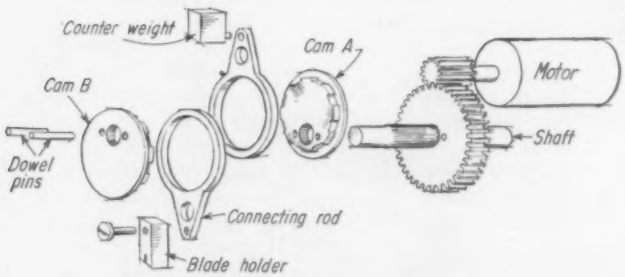
CANTILEVER SPINDLE, on which the grinding or boring head is mounted, could be affected by temperature changes during operation. To compensate for possible thermal expansion, the spindle is connected to the base of the machine by a rod designed to expand an equal amount in the opposite direction. Temperature variations of up to 3.5 deg F do not impair normal operations. Lateral forces caused by expansion of the compensating rod are absorbed by leaf-spring connectors which are rigid in the lateral direction.

for smooth sawing:

DOUBLE ECCENTRICS

Vibrationless transition from rotary to reciprocal motion was the design objective with this sabre saw. Stamped connecting rods, mounted on two eccentric bronze bearings, solved the problem after other designs had been rejected.





FINAL CHOICE was a double-throw fabricated crankshaft with a reciprocating counterbalance. Crankshaft has two porous bronze cams, and a gear holding a straight shaft and two dowel pins. To insure proper alignment of cams and drive gear, all parts are fixtured and drilled at time of assembly. Predrilled, hardened gear is used as a drill bushing. While still in the fixture, the shaft and dowel pins are pressed into position to lock the assembly. Lubrication problem was solved by using a discontinuous bearing surface on the cams to provide a pocket for grease retention.

Square blade-chuck prevents transmission of blade twist to connecting rod. Felt washer and steel retainer act as wiper and seal to keep grease in and dust out. Diecastings are aligned by pads and pins in the as-cast condition, without machining.

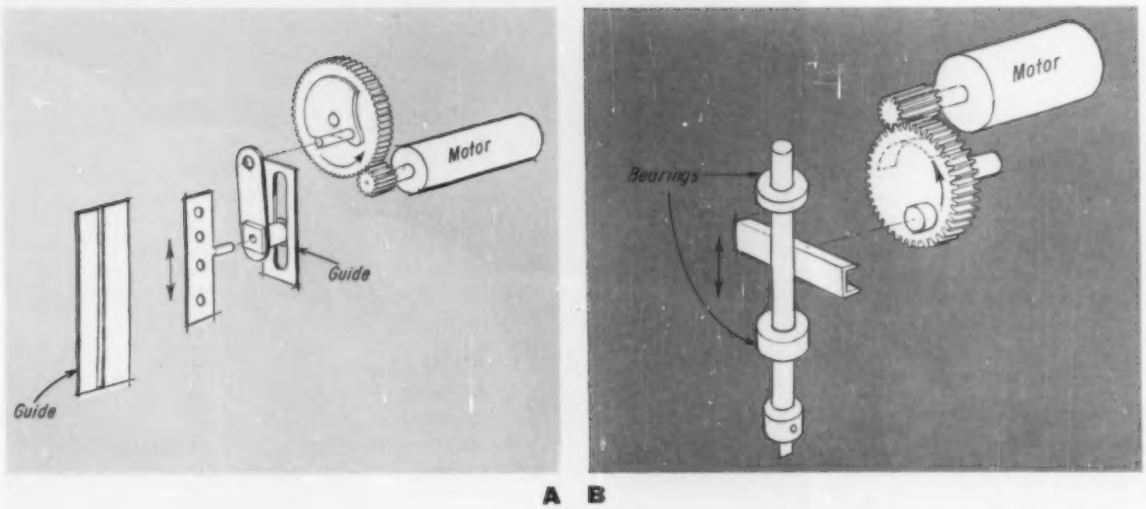
PS . . . Basic problem of sabre-saw design was balancing driving forces and eliminating vibration when rotary motion of the motor is converted into reciprocating motion of the saw blade. Lubrication was another problem, since saw must be partially disassembled to add grease. Numerous solutions were evaluated before an acceptable design was selected and prototypes produced. Sabre-Jig hand-saw Model 466 is produced by John Oster Manufacturing Co, Milwaukee.

ROTARY-TO-RECIPROCAL converters are common. The double-eccentric design was chosen after evaluating these factors: balance, lubrication, manufacturing cost, wear and serviceability. Here's why some of the other designs were rejected:

Balancing a reciprocating action with a single rotating member (A and B) is difficult, especially when the unbalanced forces are not in the same plane. These actions frequently produce a side-to-side rock or a fore-and-aft buck. Bevel gears permit the forces to be aligned in the same plane (C) but the mechanism is complex, expensive to produce, and has a large number of elements subject to wear.

Adding a reciprocating weight in the horizontal direction (D) helps counterbalance the rotating weight. However, some imbalance remains because the reciprocating forces pass a zero value every half revolution and the rotating force does not. Also, there is a tendency to imbalance because the three force systems are in separate planes.

A perfect static balance is produced (E) by having double rotating members but this does not prevent the imbalance produced by forces in different planes. Double gears with dual pin yoke (F) produce perfect balance but two-gear system is expensive, and pin-yoke drive is subject to wear.


Motor
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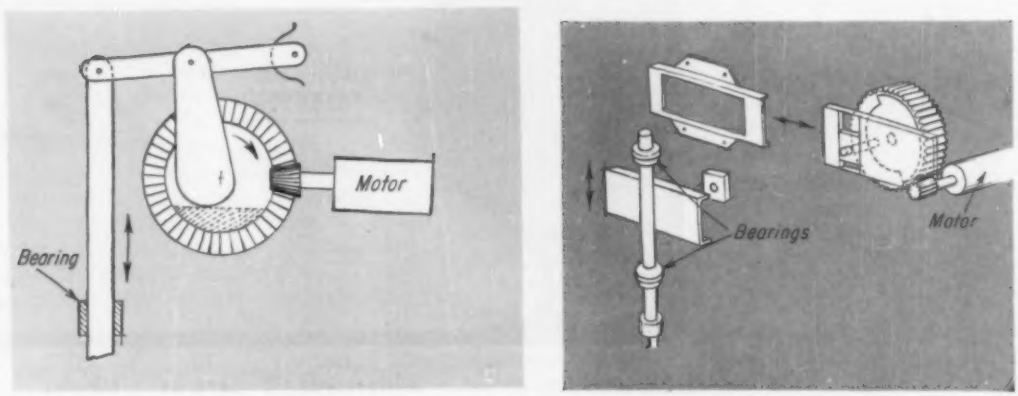
A B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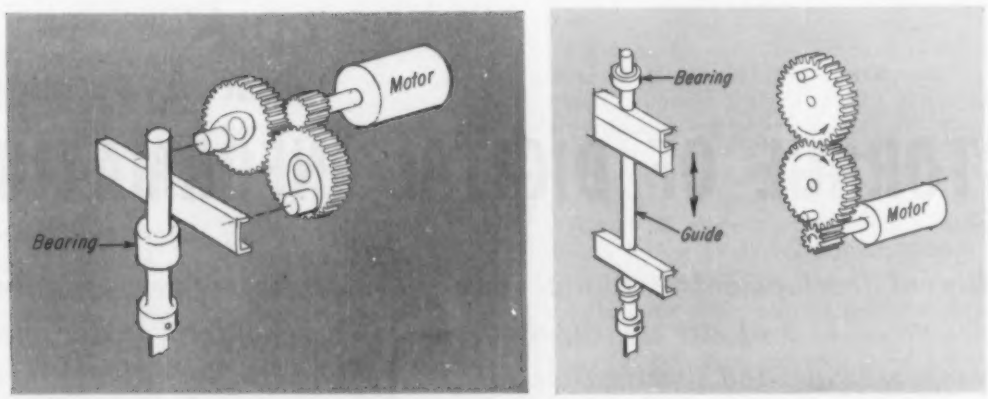
C D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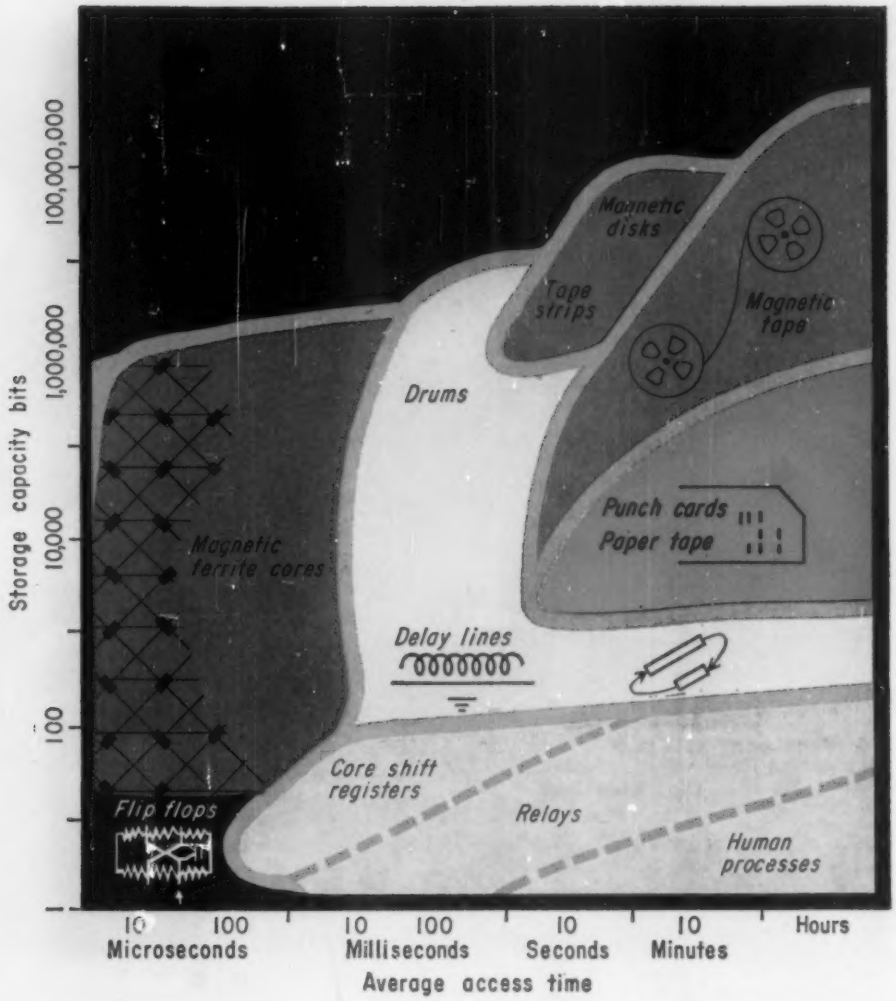

what's available for

STORAGE OF DIGITAL INFORMATION

Recent developments in digital storage devices now offer a wide range of storage capacity, increased reliability, faster speeds of entry into storage, and shorter time for retrieval—with cost advantages in many new applications. Here are the basic methods, how they operate, and where each type is best suited.

WILLIAM S KNOWLES, *senior staff engineer*
Telemeter Magnetics Inc
Culver City, Calif

Digital storage is often viewed as a radically new concept, but it is in fact quite ancient. What has changed is the substitution of electronic circuits for slower mechanical or manual means. Storage, or memory, devices are as old as the art of writing, or placing a pebble at a particular flat spot. Using a key, and turning on an electric light are good examples of a one-bit memory. The player piano utilized a form of digital storage—punched paper tape with 88 parallel bits of information automatically controlling a complex mechanism—in accordance with a previously prepared program (the musical composition).

A player piano roll is a sequential, as contrasted to a random access, type of storage. All information on the roll must be read in sequence and at a reasonably specific rate, to produce a recognizable piece of music. Conversely, use of a dictionary is an example of a random access process which locates one piece of information (a word) without the necessity of reading through the preceding sequence of words. Average access time is simply the time it takes to obtain a specific piece of stored information, and is often used as a figure of merit in describing digital storage systems.

When the speed of the data source is not compatible with the output device, a buffer or temporary storage—usually of magnetic cores—holds the data until needed. A secretary's shorthand is a form of buffer storage. In electronic memory devices a buffer may assimilate and disseminate at any rate (up to several hundred thousand characters per sec) and shift between loading and unloading without pause.

The "juke box" has a digital storage unit which remembers the users' choice of selections. Relays do this ordinarily, but one major manufacturer uses a 200-bit ferrite magnetic core for increased reliability at lower cost. Random access writing (loading) is required in this system, but unloading may be sequential.

Reliability of electronic data-storage devices was uncertain a few years ago, and the necessity for extreme speed of computation was justification for the required upkeep. Today, with solid-state components—transistors and magnetic cores—magnetic storage provides a high order of reliability at low cost.

Types of Digital Storage

Punched Cards. Storage (writing) is performed by the process of removing portions of the card material at prescribed positions, usually 80 or 90 columns of 12 row positions.

Retrieval (reading) of stored data is by electrical or mechanical contacts made through holes or reading by photoelectric means. Access time depends on number of cards in use. Handling rate is limited to a few cards per second.

Practical capacity is limited mainly by rate at which specific cards must be accessed. Repeated handling of cards causes wear. Information is regenerated or modified by punching a new card. Gives good utility where high sortability, selectability, and replaceability are needed.

Punched Paper Tape. Storage, as with punched cards, is by holes through the material. As with punched cards, modification of written information necessitates preparation of new tape. Rolls of tape may be several thousand feet long, with 120 characters punched per linear foot. Access time to read includes manual selection and threading selected reel, plus tape-handler motion time to desired portion of tape, usually at rates below 1000 characters (8 ft) per second. Practical capacity depends on updating frequency and number of accesses required per unit of time.

Relays. Setting information into relays may be done by either electrical or mechanical means; closing of a relay (writing in the information) usually takes a fraction of a second. Usually, additional contacts on the relay provide a latching condition once closed (written) so that only removal of the solenoid-driving voltage erases the information.

Access speed depends on the size of memory—and how it is used. While the state of any contact represents a previously written open or closed path, only in very simple storages can it be read without an addressing system to set up the desired path, somewhat like the sequence initiated when a telephone number is dialed.

Unlike punched cards or tape, relays are also usable in performing logic; "AND" and "OR" gate functions are readily mechanized by series or parallel connection of a number of relays. Relay storage is "volatile" in the sense that all stored information is erased by a power interruption. Relays are best suited for applications where small storage capacity is adequate, and high speeds are not required.

Flip-flop. An electronic switching circuit having two stable states, and controlled by trigger pulses. It can be operated either as a toggle (similar to toggle switch) in which separate trigger lines set and reset it; or as a scaler which changes state on every trigger impulse. The high-low headlight beam floor switch in an automobile is an example of a one-bit scaler.

Capable of submicrosecond speeds. Practical capacity limited to few dozen bits because of more economical methods for larger stores.

Delay Line. Based on the fixed and finite speed of sound, delay lines store by continuously recirculating information through a controlled transit time device. As information reaches the output of the line, it is amplified, modified (if required), and reinserted in the line. Transit time of the line is usually in the millisecond region. Transit time of the line defines the access time. Number of bits stored in a line usually less than one thousand;

TYPES AND CHARACTERISTICS OF DIGITAL STORAGE SYSTEMS

Class	Type of Access	Average Access Time	Storage Capacity	Operating Rate (bits/sec)	Life, passes	Resistance to			Physical Dimensions	Power Required	Reliability
						Shock vibra.	Grit, moist.	Temp. change			
Paper Punched Card	Seq.	Minutes	Large	Variable to 3000	Few hundred	Good	Poor	Good	Medium	Medium	Fair
Paper Tape	Seq.	Minutes	Medium	Variable to 5000	Few hundred	Good	Poor	Good	Small	Low	Fair
Relays	Random	Microsec	Small	Fast read, slow write	Fair	Poor	Poor	Good	Small to Medium	Small to Medium	Fair
Flip-flops	Random	Microsec	Small	Variable, millions	Very good	Exc.	Exc.	Good	Small to Medium	Small to Medium	Good
Acoustic (delay line)	Seq.	Millisec	Small	Fixed to 1,000,000	Infinite	Fair	Good	Poor	Small to Medium	Small to Medium	Good
Magnetic Tape	Seq.	Minutes	Large	Fixed, appr. 100,000	Few thousand	Good	Poor	Fair	Large	High	Good
Tape Strip	Semi-random	Seconds	Medium		Few thousand	Good	Poor	Fair	Large	High	Good
Disk	Semi-random	Seconds	Medium		Infinite	Poor	Poor	Fair	Small to Large	Medium	Good
Drum	Semi-random	millisec	Medium	Fixed to 1,000,000	Infinite	Fair	Poor	Fair	Small to Large	Medium	Good
Core	Random	Microsec	Medium	Variable to 50,000,000	Infinite	Exc.	Exc.	Good	Small to Medium	Low to Medium	Exc.
Card	Semi-random	Seconds	Large	Variable to 600,000	100,000	Good		Good	Large	High	Good
Shift Reg.	Seq.	Millisec	Small	Variable to 100,000	Infinite	Exc.	Exc.	Good	Small	Low	Exc.

paralleled lines often used for greater capacity. Used in moderate-speed computers where synchronous operation is acceptable.

Shift Register. A sequential device, usually fabricated from a chain of flip-flops or magnetic cores, in which each character or digit stored causes a shift of all previously stored bits, and the simultaneous release of the earliest bit of the stored data. A simple analogy is a tube full of black and white marbles. Pushing in an extra one will discharge a marble from the far end, and as successive operations are performed, each marble shifts one position toward the release terminal. Shift registers have been built to operate at bit rates as high as 1 megacycle.

Used where relatively small capacity is adequate, since other methods are usually more economical and faster, where more than a few dozen bits of storage are needed.

Magnetic Storage Devices

A wide variety of digital storage devices are based on the physical phenomena of residual magnetism. Magnetic digital storage has permanence, reliability, speed, and moderate cost. Miniaturization is receiving much attention, and a variety of magnetic cell configurations are under development. Still smaller magnetic cores, poly-apertured cores, thin films, apertured plates, rods, twistors and plated wire, are among the variations.

Magnetic Drums. A cylinder coated with magnetic material is rotated at high speed, with a series of read-write

heads positioned along the drum. Information is stored sequentially by energizing the heads at appropriate times corresponding to angular positions. Read-access time usually is in the region of milliseconds. Drums having capacities of millions of bits have been made, although the usual size is considerably smaller. Used in a variety of computer applications.

Magnetic Tape. In digital storage applications, the tape handler normally writes seven or eight parallel tracks of information along the tape. Equipment is designed to start or stop the tape within a fraction of an inch, so that discrete blocks of data may be used, with blank areas between blocks compatible with the start-stop operation. Tape travels at rates permitting tens of thousands of characters per second to be handled, but access time increases directly with amount of storage.

Average access time is several minutes after selected tape-handler is loaded. Upper capacity is practically unlimited. Most economical for large-volume storage requirements. Because tape must be written and read at one fixed speed, its use presents a problem when stored data are needed at some other rate than the fixed speed permits. Some intermediate or buffer storage system may then be needed.

Magnetic Cores. Information is stored on individual ferrite rings as small as 0.03 in. dia and 0.006 in. thick. Wiring through these elements allows random access writing (by coincident currents). Access times as short as one microsecond. Range of practical capacity is from very few bits to millions. Unlimited life; extremely reliable; compact. Widely used in newer, higher speed, random access computers, and now finding recognition in many lower speed, highly reliable, and low-cost industrial control application. Magnetic cores are often used to perform logic operations.

Selecting a Storage Device

Storage capacity, speed, and cost per bit are interrelated. In some applications cost-per-bit per unit of access time is important; in other cases, it is not. Generally, for very small storage capacities (less than a few dozen bits) the speed required determines whether a bit-by-bit method such as relays is best, or whether a "cover charge" of a power supply and peripheral circuitry for the storage cells is warranted.

Capacities over a few dozen bits and up to many thousands are in a region where access speed has less bearing on price than on the size of the store; in this middle region the cost per bit dips well below $1, and fast-access types may not entail higher cost.

In the very high capacity region, cost per bit can become extremely low—if slow access is allowable.

Because of large differences in characteristics among methods of digital storage, it is necessary to establish criteria of equivalent self-sufficiency from type to type. For example, a current magnetic-core random-access store, complete with power supply and input/output register, and having a capacity of 1024 words of 24 bits each, has a price of less than 75 cents per bit, and operates at any rate up to several hundred thousand words per second. The quantity of data stored at any one instant could be written on a few inches of magnetic tape, but considering the tape handler and peripheral equipment, over-all cost for this amount of storage would be higher, and access rates lower. Conversely, if millions of bits in storage are required at lower access rates, tape is attractive.

Additional Storage Methods. Many types of digital storage cells, in addition to those previously described, are being developed. Others have reached obsolescence. Some are offshoots of the methods described, others are based on different physical principles.

Many groups are actively engaged in developmental work on a variety of devices such as barrier grid tubes, gas discharge tubes, Williams tubes, capacitor stores, and other electrostatic means; ferroelectric devices, ferroresonance, cryogenics, optical scanning; some of the magnetic devices —mentioned earlier—are currently either in development, available for rather special purpose usage, or obsolete.

Compatibility and External Requirements. If an industrial process or product is to be controlled properly by a digital storage device, input-output signals of a static character (steady-state signals in contrast to momentary pulses) are desirable. Output signals should be sufficient to operate control circuits of the machinery being automated. The storage device must be compatible with the particular application. Almost invariably, some control logic for the storage unit is needed to satisfy the demands of an automated system. To integrate the storage unit, the system must not only be compatible with the storage device (and preferably its power supply) but must also generate a variety of control signals.

Recently, a number of "self-sufficient" black box digital storage devices have become commercially available. These products are designed to meet a wide range of digital system storage requirements, thereby offering the industrial system designer packaged components for built-in use. Such systems offer quick delivery and proved techniques.

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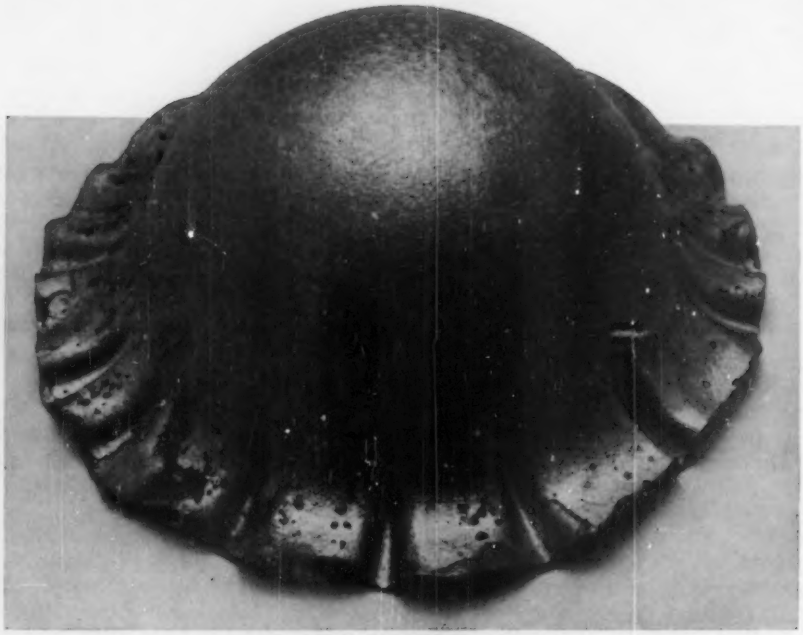
EDITOR'S NOTE. These earlier articles give background information on information storage, computers and automatic control:

Design by Digital Computers, Apr 11 '60, p 43—Includes a discussion of the specialized vocabulary of information storage, input-output methods, and memory systems having special application to digital computers.

Magnetic-drum Storage Devices, Aug '53, p 192—A detailed comparison of 10 devices available at that time.

Making Machines Remember, Apr '53, p 141—A thorough evaluation of nine types of storage media available at the time, including some now superseded.



Although this metal is soft, it's also brittle. That's why beryllium sheet had to be heated before drawing the 2-in.-dia hemisphere shown above—one of several precautions necessary when . . .

FORMING BERYLLIUM SHEET

HERBERT A JAHNLE
Metallurgical project engineer
The Budd Co

With tensile yield strengths equalling that of annealed 301 stainless, a density only slightly more than that of magnesium, and an elastic modulus of 44 million psi, beryllium is the lightest, most compact metal for a structural shape with a given rigidity. But technology does not permit a new lightweight contender like beryllium to compete with older materials just on the basis of a few important properties. Furthermore, the new metal has to overcome a big handicap—lack of production know-how such as for fabricating lightweight sheet structures.

Although beryllium sheet can be cut, bent and deep-drawn, its brittleness at room temperatures limits most forming to hot working at temperatures of 1000 to 1400 F. Its high price (present sheet prices range from a few hundred dollars to over $1000 per lb); unavailability of uniform sheet; and the accompanying toxicity hazards—have held back beryllium's wider use.

Beryllium—the Metal

So-called pure beryllium metal contains from 0.75 to 2.5% beryllium oxide plus a total of about 0.15% other impurities—iron, aluminum, manganese nickel and chromium. Lower oxide content gives better ductility but also lowers room- and elevated-temperature properties.

Beryllium's close-packed hexagonal crystal structure slips most easily along its basal plane at room temperatures. The metal is brittle because slip is limited to a few percent before the metal fractures. At higher temperatures, resolved sheer stress required for slip on other planes is lower than for basal slip and ductility is increased.

Beryllium fractures easily along three other planes in the crystal. These planes join every other point of the hexagon, and are 60 or 120° to each other.

Massive shapes in beryllium are obtained by hot-pressing fine metal power. (All forms of beryllium start this way. Casting the metal from the molten state gives grains too large for practical use.) Within each grain all the crystals are lined up in the same way, but small randomly orientated grains average out directional properties.

The Sheet Material

Most of the sheet available is made by cross-rolling, which gives the best combination of strength and ductility. Rolling the material into sheet orientates the basal planes parallel to the surface. This preferred orientation increases ductility parallel to sheet surface while ductility through the sheet becomes poorer. If the sheet is rolled in one direction only, the hexagons, as visualized from their top view (see illustrations below) are lined up with one edge in the rolling direction. This lets the metal split easily along the three fracture planes. Alternating the rolling direction (cross rolling) increases the ductility parallel to the surface without making the sheet so susceptible to the three-way cracking.

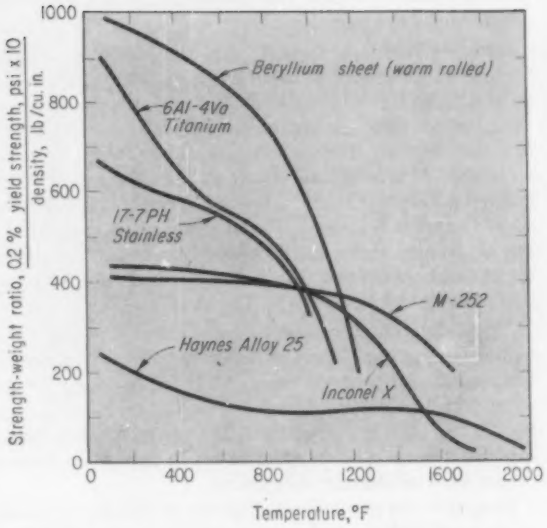
Before fabricating it, the sheet is stress-relieved for 10 min at 1400 F to restore what little ductility the metal has lost by the working. Very little beryllium material, whether sheet or any other form, is used in cold-worked form because the ductility is too low for the worked metal.

Beryllium should not be heated over 1500 F because it could recrystallize to form large grains. These have boundaries that are too continuous for high strength. All working and forming beryllium is done warm. Metallurgically, this means below recrystallization point.

In our original tests to develop fabricating techniques, we used cross-rolled sheet, 0.023 in. thick. It had been rolled from a block of beryllium powder previously pressed hot in a vacuum. The block was enclosed in a jacket, then rolled warm at 1450 F with an over-all reduction of 26 to 1. The sheet as received had a rough, wavy surface and showed many surface pits where the metal had apparently bonded to the jacketing material. The 0.023-in. sheet was fabricated as received except that which underwent corrugation tests. Here the metal was rerolled to 0.012 inches in four to five passes through a 4-high mill prior to forming.

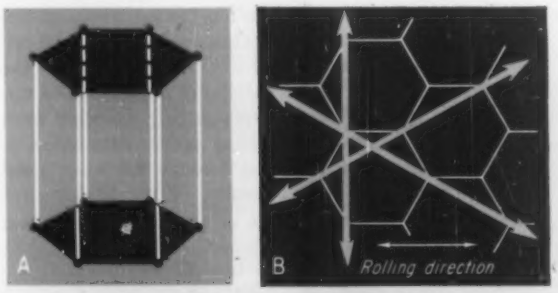
One of the drawbacks today is the difficulty of obtaining sheet beryllium of uniformly high quality. This grade is not available in large quantities and the small demand has not pushed suppliers to improve sheet quality. Our tests were run on available sheet. (At the time, sizes were limited to those in the table on page 75.)

Many of our possible applications admittedly require a better finish than that which is available today. This, despite the fact that sheet available now is much better than that of a short time ago. Another problem: properties from sheet to sheet vary (the same problem faced by titanium several years ago). It is difficult to predict what gage tolerances and flatness can be ultimately made, but



BERYLLIUM EXCELS in strength-to-weight ratio to beyond 1100 F. Curve compares other materials noted for their high strength and light weight.

HEXAGONAL, CLOSE-PACKED, STRUCTURE of beryllium sheet is illustrated by this prism (A). Rolling will line up basal planes, (B) parallel to face of sheet, and side of hexagon parallel to direction of rolling. Three arrows show direction of planes of easy fracturing. Three-way split at spot-weld nugget, (C), shows proneness of sheet beryllium to crack when rolled in only one direction.



there is reason to believe that the standard steel tolerances can be met if the price for such rolling is paid.

Shearing beryllium sheet thicker than 0.020 in. should be done above 1000 F to avoid cracking. Thin sheet below 0.010 in. can in some cases be cut easily at room temperature; but as thickness increases (especially beyond 0.040 in.) the shearing temperature has to be hotter to get a clean cut. This is because shears must be set with a wider gap for thicker sheet and such sheet is bent slightly by the shears before it is severed. Room temperature shear cracks run at definite angles to the sheared edge and the rolling direction. Cracks formed in hot shearing do not have any particular orientation.

Bending is more consistent and radii can be sharper if material is heated. At room temperatures, the minimum bend radius is about 40 times the thickness using 1½-in.-wide strips. At 1300 F, bends are limited to 3T. For multiple bends such as corrugations, the material has to be reheated for each bend in order to attain accurately formed shapes with consistent dimensions.

Deep-drawing properties at high temperatures are similar to those of carbon steel at room temperature except that total elongation of beryllium is about ⅓ to ½ that of carbon steel. Drawing of beryllium cannot be done cold. Shallow cylindrical shapes with a 2-in. dia and ¼-in. wall have been drawn without flanges.

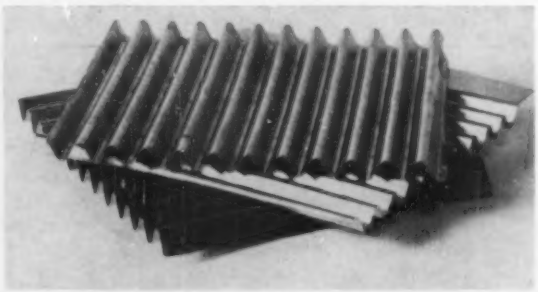
Drawn hemispheres from 0.040-in. sheet had a 2-in. dia and constant wall thickness. In forming, material was stretched approximately 18%. Sheet must be held at flange with sufficient force to prevent wrinkling of the drawn shape.

Brazing by silver and aluminum brazing alloys showed good wettability. The brazing alloys do not flow to any extent, therefore joints should be so designed that braze metal put in place prior to heating. Since beryllium diffuses readily into any metal, brazing cycles must be short. This diffusion also limits useful service temperature of the braze-assembled part. When beryllium is brazed to a second metal, time at brazing temperature becomes even more critical. Here, short brazing cycles are needed to prevent beryllium from diffusing through the braze metal into the other metal and embrittling it.

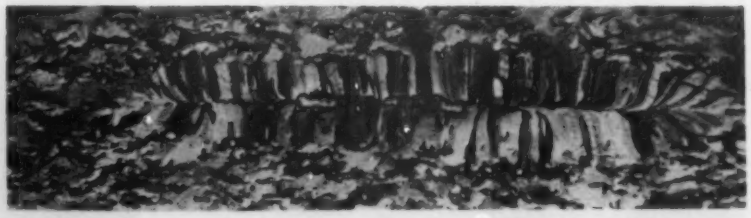
Spot welding was successful in the pitted as-received

PROPERTIES OF BERYLLIUM SHEET
(0.060-in. warm-rolled sheet)

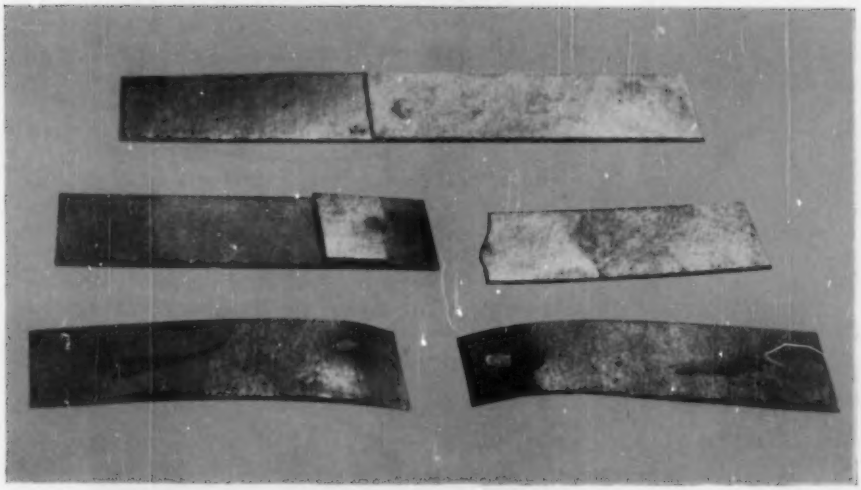
Physical			
Hardness, Rockwell B			98 to 102
Density, lb/cu in.			0.067
Thermal Conductivity			
at room temperature, btu/ft/ft²/hr/°F			87
at 1200 F, btu/ft/ft²/hr/°F			65
Coefficient of Thermal Expansion			
RT to 212 F, in./in./°F			6.39×10^{-6}
RT to 1260 F, in./in./°F			9.57×10^{-6}
Mechanical			
Tensile Strength	UTS, psi	0.2% yield, psi	Elong, %
at RT	80,000	65,000	5
600 F	65,000	57,000	25
800 F	55,000	50,000	20
1200 F	15,000	15,000	15
Modulus of Elasticity-E, psi			
at RT	44 million		
at 1000 F	40 million		



CONSISTENT CORRUGATIONS require close temperature control. The beryllium here had to be reheated for each bend. Height of each ridge is ¼ in., radius is 0.040 in.



SPOT-WELD NUGGET shows large columnar grains where metal was melted. Special weld procedures can be used to refine the grains.



BROKEN SPOT-WELD specimens, all of equal strength, show difference between brittle and ductile failure. Center is weld specimen pulled at room temperature. The break was not at the weld (the brittle sheet metal failed in bending). Bottom weld, pulled at 800 F, was ductile. Although beryllium base metal has 30% lower strength at 800 F, increased ductility redistributed stresses, enabling each specimen to carry same load.

Sizes Available in Beryllium Sheet

Thickness, in.	Area dimensions, in.
0.005 to 0.020	12 × 24
0.020 to 0.060	20 × 36
0.060 to 0.125	30 × 60
0.125 to 0.250	30 × 72
0.250 to 1.0	24 × 48

sheet. The smoother, rerolled sheet was easier to weld because it did not have the surface defects that initiate cracking. Parts to be spot-welded must mate together and contour of the electrodes must match that of the part, or the metal will tend to crack.

Welds were most consistent in nugget size and pull strength when the cycle was controlled with the Budd Monautronic Control. This patented electronic system maintains consistent weld heat by sensing changes in the electrical resistance of the joint. The control then automatically compensates by adjusting welding voltage and current.

Arc welding was done manually by tungsten arc without filler metal. The beryllium was welded inside a sealed chamber, which was first evacuated, then refilled with high-purity inert gas—argon or helium. Butt and edge welds on 0.023- and 0.125-in. sheet were successfully made.

A typical deposit in a butt weld had large columnar grains. At the edge of the deposit, the grains formed parallel to the surface. The orientation gradually changed so that at the weld center the columns were perpendicular to the surface. Hot bend tests showed that the arc welds were ductile when welds were bent either parallel or perpendicular to the axis of the deposit. However, the welds were prone to cracking during bending when columnar grains extended completely through the sheet.

Some oxides were trapped in the arc welds. These apparently came from the oxides in the original material.

Avoiding Toxicity Hazards

Beryllium presents a potential health hazard. To avoid the serious danger of beryllium-induced disease, atmospheric concentration of the metal should not exceed an average concentration of 2 micrograms per cubic meter for an 8-hour day. And at no time, however short, should any person be exposed to more than 25 micrograms per cubic meter. Any cuts or scratches from sharp edges of beryllium should be thoroughly cleaned. Because it is so brittle, the metal should be kept in boxes which will resist rough handling. This will prevent accidental cuts.

EDITOR'S NOTE: Other recent articles on how to design structures with thin metal sheet:

Stronger Parts from Work-hardened Sheetmetal, Oct 26, p 76—How to use this material in welded structures. Article gives joint designs for optimum fatigue strength and high tensile efficiency.

Meet the "Insect-wing" Metal Panel, Mar 16 '59, p 62—Special technique in constructing twin-sheet panels. Dimples and spot welds give rigidity and light weight.

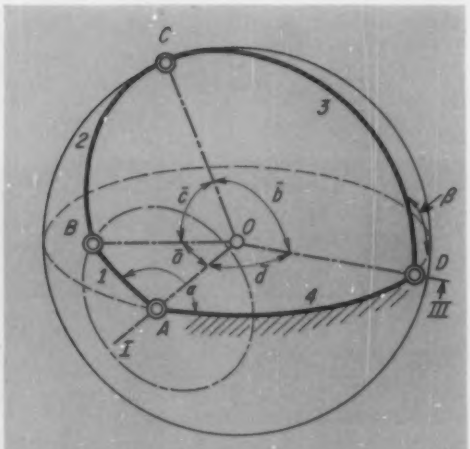
7 Closer Looks at Metal Properties, Oct 27 '58, p 48—Mechanical properties that seem hidden—but can be found right in the test data—help get around design troubles.

Watch Out for Compression Loads, Dec 9, '57, p 72—Contrary to popular notion, metals are not as strong in compression as they are in tension. Buckling loads are particularly critical for sheetmetal designs.

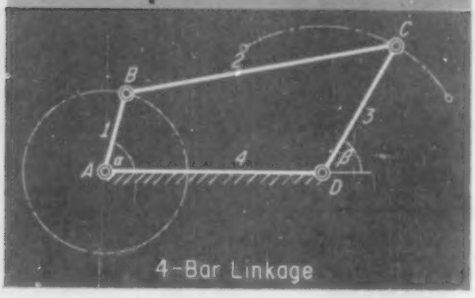
Seven popular types of

THREE-DIMENSIONAL DRIVES

Main advantage of three-dimensional drives is their ability to transit motion between nonparallel shafts. They can also generate other types of helpful motion. With this roundup are descriptions of industrial applications.



The Spherical Crank



4-Bar Linkage

1 spherical crank drive

This type of drive is the basis for most 3-D linkages, much as the common 4-bar linkage is the basis for the two-dimensional field. Both mechanisms operate on similar principles. (In the accompanying sketches, α is the input angle, and β the output angle. This notation has been used throughout the article.)

In the 4-bar linkage, the rotary motion of driving crank *1* is transformed into an oscillating motion of output link 3. If the fixed link is made the shortest of all, then you have a double-crank mechanism, in which both the driving and driven members make full rotations.

In the spherical crank drive, link *1* is the input, link 3 the output. The axes of rotation intersect at point *O*; the lines connecting *AB*, *BC*, *CD* and *DA* can be thought of as part of great circles of a sphere. The length of the link is best represented by angles *a*, *b*, *c* and *d*.

DR W MEYER ZUR CAPELLEN, *professor of kinetics, Aachen Institute of Technology, Germany*

ABOUT THE AUTHOR

Professor Meyer zur Capellen is a well-known German expert on linkage design. He holds degrees in mathematics and physics—but his pet subject is kinematics, which he teaches at Aachen's Institute of Technology. He has published over 80 papers on kinematics, mechanics and applied mathematics, and has found time to write a number of technical books including *Mathematical Instruments, Instrument Mathematics for Engineers* and *A Guide to Nomographs.*

2 spherical-slide oscillator

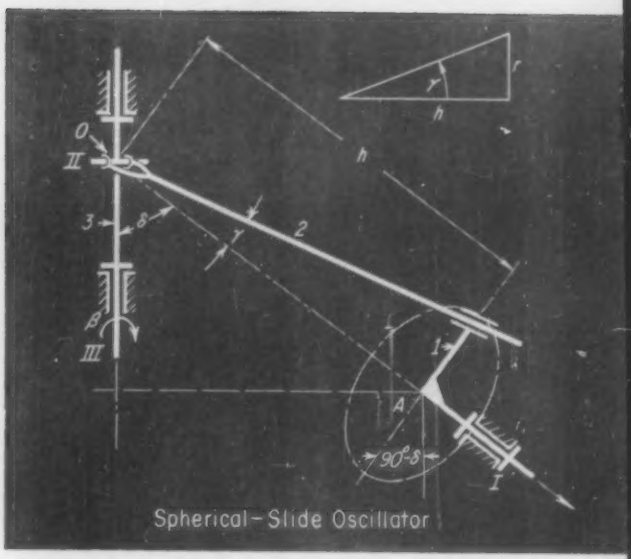
The two-dimensional slider crank is obtained from a 4-bar linkage by making the oscillating arm infinitely long. By making an analogous change in the spherical crank, you can obtain the spherical slider crank shown at right.

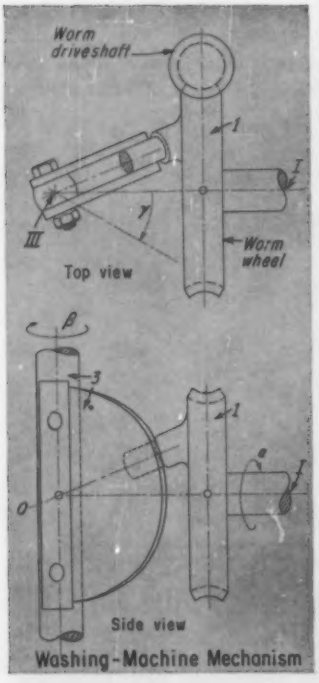
The uniform rotation of input shaft I is transferred into a nonuniform oscillating or rotating motion of output shaft III. These shafts intersect at an angle δ corresponding to the frame link 4 of the spherical crank. Angle γ corresponds to length of link *1*. Axis II is at right angle to axis III

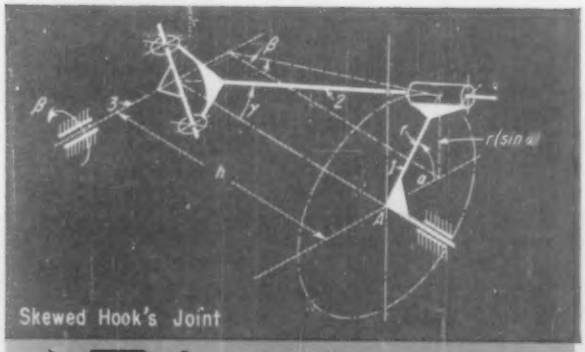
The output oscillates when γ is smaller than δ; the output rotates when γ is larger than δ.

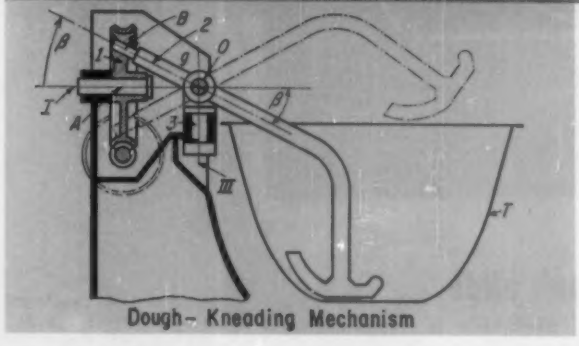
Relation between input angle α and output angle β is (as designated in skewed Hook's joint, below)

$$\tan \beta = \frac{(\tan \gamma)(\sin \alpha)}{\sin \delta + (\tan \gamma)(\cos \delta)(\cos \alpha)}$$









3 skewed hook's joint

This variation of the spherical crank is often used where an almost linear relation is desired between input and output angles for a large part of the motion cycle.

The equation defining the output in terms of the input can be obtained from the above equation by making $\delta = 90°$. Thus $\sin \delta = 1$, $\cos \delta = 0$, and

$$\tan \beta = \tan \gamma \sin \alpha$$

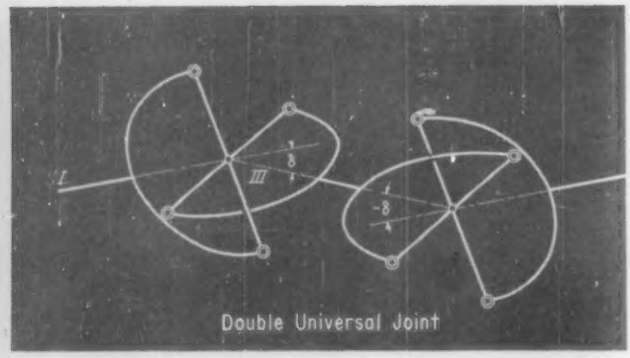
The principle of the skewed Hook's joint has been recently applied to the drive of a washing machine (see sketch at left).

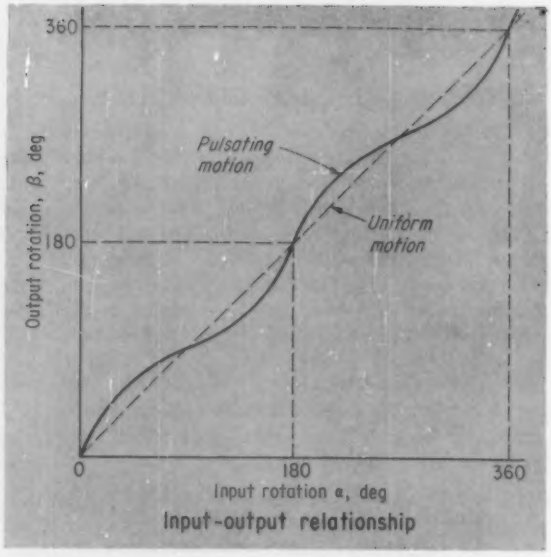
Here, the driveshaft drives the worm wheel *1* which has a crank fashioned at an angle γ. The crank rides between two plates and causes the output shaft III to oscillate in accordance with the equation above.

The dough-kneading mechanism at right is also based on the Hook's joint, but utilizes the path of link 2 to give a wobbling motion that kneads dough in the tank.

THREE-DIMENSIONAL DRIVES . . .

continued





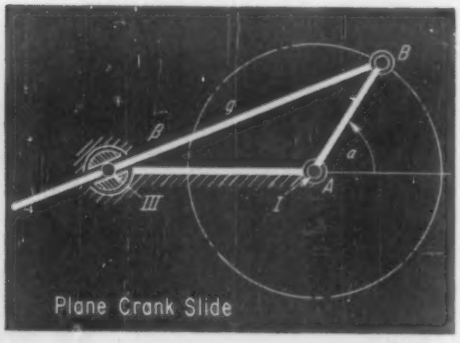
4 the universal joint

The universal joint is a variation of the spherical-slide oscillator, but with angle $\gamma = 90°$. This drive provides a totally rotating output and can be operated as a pair, as shown above.

Equation relating input with output for a single universal joint, where δ is angle between connecting link and shaft I:

$$\tan \beta = \tan \alpha \cos \delta$$

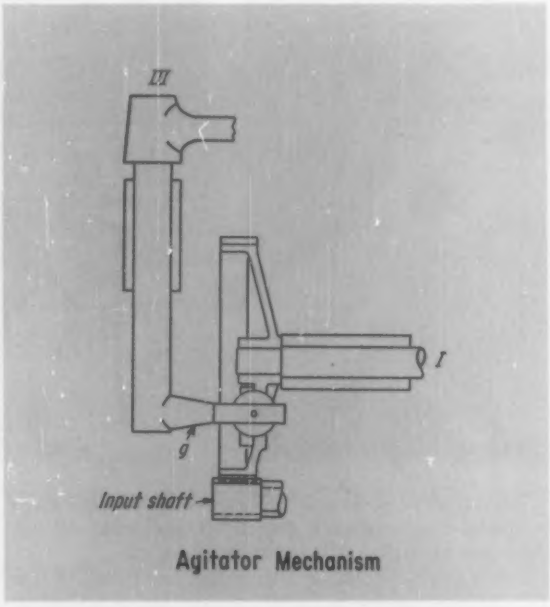
Output motion is pulsating (see curve) unless the joints are operated as pairs to provide a uniform motion.

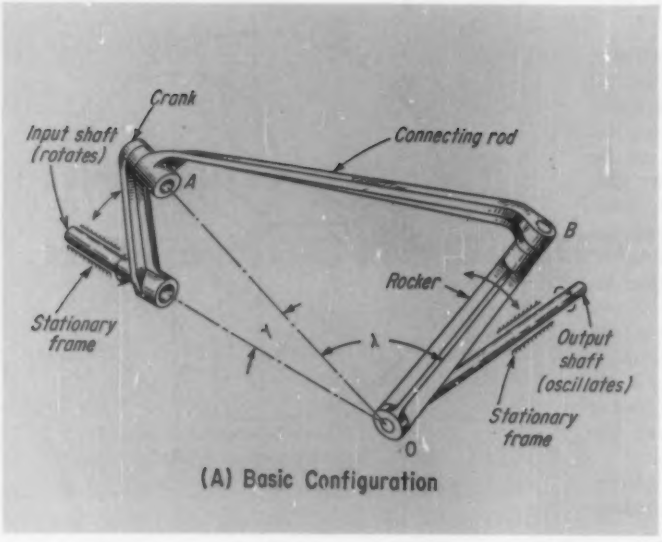


5 the 3-D crank slide

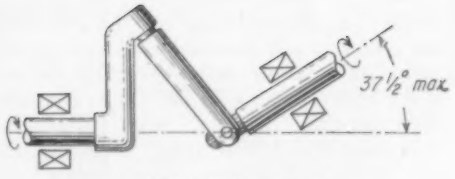
The three-dimensional crank slide is a variation of a plane crank slide (see sketch), with a ball point through which link g always slides, while a point B on link g describes a circle. A 3-D crank is obtained from this mechanism by making output shaft III not normal to the plane of the circle; another way is to make shafts I and III nonparallel.

A practical variation of the 3-D crank slide is the agitator mechanism (right). As input gear I rotates, link g swivels around (and also lifts) shaft III. Hence, vertical link has both an oscillating rotary motion and a sinusoidal harmonic translation in the direction of its axis of rotation. The link performs what is essentially a screw motion in each cycle.

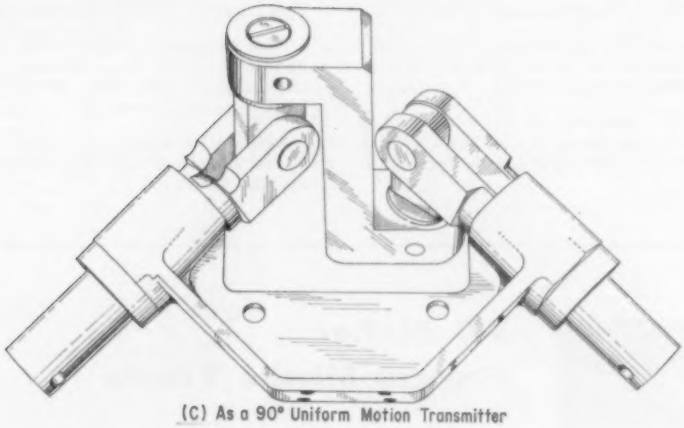




(A) Basic Configuration



(B) Its Inversion


(C) As a 90° Uniform Motion Transmitter

6 the space crank

One of the most recent developments in 3-D linkages is the space crank shown in (A) see also PE—"Introducing the Space Crank—a New 3-D Mechanism," Mar 2 '59. It resembles the spherical crank discussed on page 76, but has different output characteristics. Relationship between input and output displacements is:

$$\cos \beta = (\tan \gamma)(\cos \alpha)(\sin \beta) - \frac{\cos \lambda}{\cos \gamma}$$

Velocity ratio is:

$$\frac{\omega_o}{\omega_i} = \frac{\tan \gamma \sin \alpha}{1 + \tan \gamma \cos \alpha \cot \beta}$$

where ω_o is the output velocity and ω_i is the constant input velocity.

An inversion of the space crank is shown in (B). It can couple intersecting shafts, and permits either shaft to be driven with full rotations. Motion is transmitted up to 37½° misalignment.

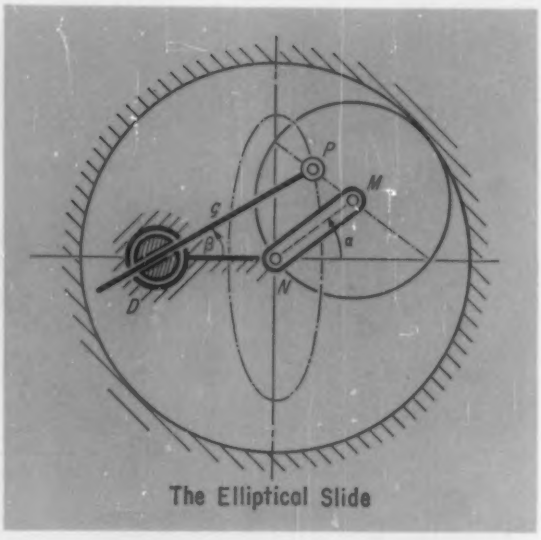
By combining two inversions, (C), a method for transmitting an exact motion pattern around a 90° bend is obtained. This unit can also act as a coupler or, if the center link is replaced by a gear, it can drive two output shafts; in addition, it can be used to transmit uniform motion around two bends.

7 the elliptical slide

The output motion, β, of a spherical slide oscillator, p 77, can be duplicated by means of a two-dimensional "elliptical slide." The mechanism has a link g which slides through a pivot point D and is fastened to a point P moving along an elliptical path. The ellipse can be generated by a Cardan drive, which is a planetary gear system with the planet gear half the diameter of the internal gear. The center of the planet, point M, describes a circle; any point on its periphery describes a straight line, and any point in between, such as point P, describes an ellipse.

There are certain relationships between the dimensions of the 3-D spherical slide and the 2-D elliptical slide: $\tan \gamma / \sin \delta = a/d$ and $\tan \gamma / \cot \delta = b/d$, where a is the major half-axis, b the minor half-axis of the ellipse, and d is the length of the fixed link DN. The minor axis lies along this link.

If point D is moved within the ellipse, a completely rotating output is obtained, corresponding to the rotating spherical crank slide.



The Elliptical Slide

EDITOR'S NOTE: For more information on two-dimensional linkages and Cardan-gear mechanisms see:

Ways to Change Straight-line Direction—In two parts: Feb 29 '60, p 61; and Mar 7 '60, p 59. Arrangements of linkages, slides friction drives and gears.

5 Graphical Methods for Designing 4-bar Linkages, Apr 4 '60, p 37—This 11-page special report covers linkages that can generate approximately a straight-line path. Copies are available for 25 cents each.

5 Cardan-gear Mechanisms, Sep 28 '59, p 66—These convert rotation into straight-line motion without sliderways.

New Equations Locate Dwell Position of 3-gear Drives, June 8 '59, p 80—These drives produce three different motion patterns—depending on location of output gear with respect to input gear.

Graphical Synthesis of 4-bar Linkages, Feb 2 '59, p 40—Author's method simplifies design of linkages to generate specific functions.

3-D Plotter Freezes Missile Tracks

This three-dimensional plotter coupled to radar and an analog computer shows instantly the trajectory of an enemy missile still thousands of miles away. It was developed initially by Chrysler Corp after noting that a three-dimensional plotter was included in the 10 most wanted devices in a 1958 listing issued by the National Inventors Council.

The plotter consists of a stylus suspended in an optically clear tank containing a transparent gel. Signals from an analog computer to servomotors move the stylus in any direction. Various colored inks are fed under pressure through the stylus as it moves through the gel; the gel closes behind the stylus retaining the ink tracings precisely in suspension.

Production version of the plotter will have a stylus with three ink channels. Traces may be retained as long as desired and then erased with a suction tube; or ink with varying degrees of persistence may also be used.

The plotter is also adaptable to weather mapping, satellite tracking, and machine-tool control.

common area of

INTERSECTING CIRCLES

Here's a fast method that will give quick, preliminary estimates.

L E IVERSEN, *Design Analysis Section*
International Harvester Co, Melrose Park, Ill

■ If you're given the radii of two intersecting circles and the distance between their centers, you can calculate their approximate common area quickly by means of this graph and formula.

Instead of solving many equations of considerable length (which you must do for exact area), all you do is select a constant, K, from the graph, subtract it from 1, and multiply by the area of one of the circles (see symbols).

To find K, use the ratio of radii $\frac{R}{r}$ for the abscissa, and ratio of distance between centers to one radius $\frac{c}{r}$ as the ordinate.

EXAMPLE Find area common to two circles with radii of 2 in. and 3 in., whose centers are 1.75 in. apart.

continued on page 83

SYMBOLS

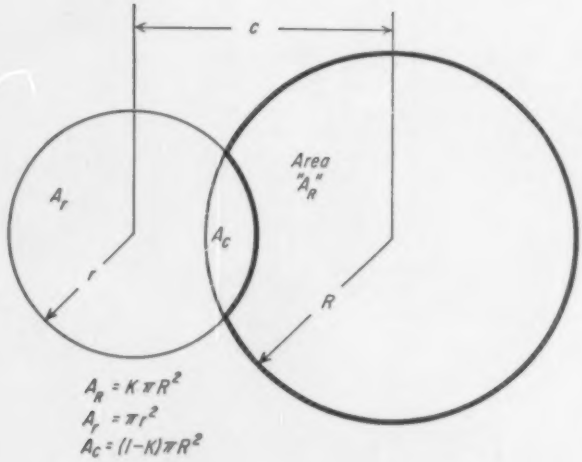
C = distance between centers

r, R = radii of circles

$A_R = K\pi R^2$ = partial area of circle R with no area common to circle r

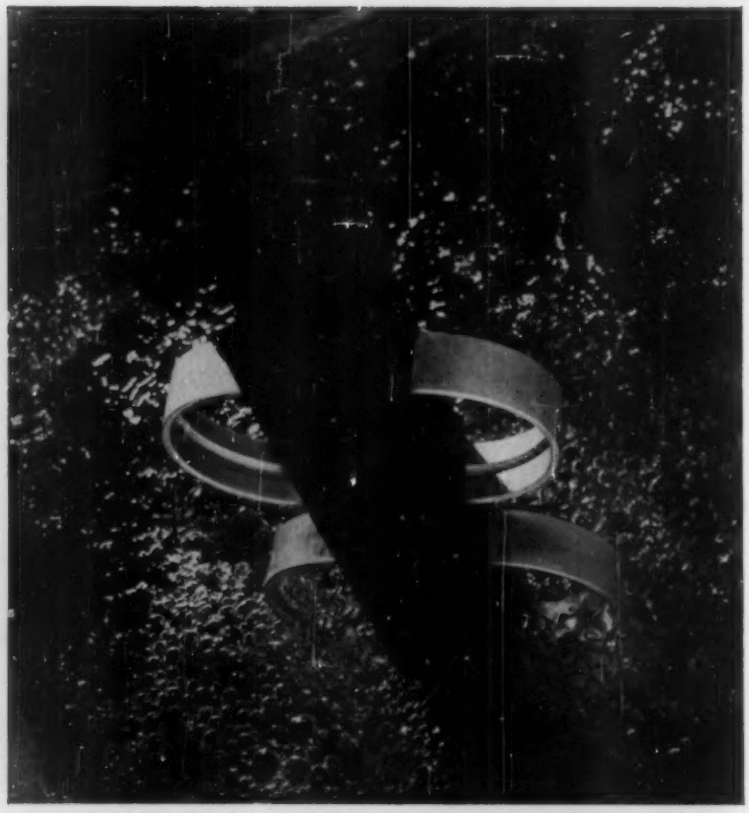
$A_r = \pi r^2$ = total area of circle r, including area common to circle R

$A_C = (1 - K)\,\pi R^2$ = area common to both circles



$A_R = K\pi R^2$
$A_r = \pi r^2$
$A_C = (1-K)\pi R^2$

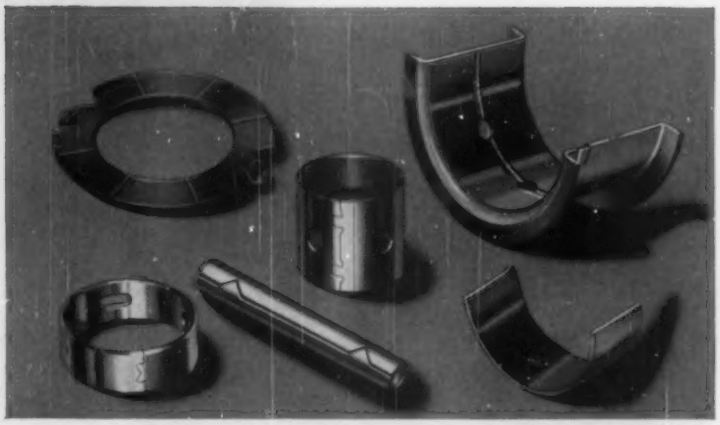
75-MILLIONTHS OF AN INCH BARRIER HALTS METAL MIGRATION



JUST BENEATH THE FRESH OVERPLATE OF THESE F-M ENGINE BEARINGS (LEFT) LIES A TENUOUS DIFFUSION BARRIER. Though this film of metal is only 75-millionths of an inch thin, it stops tin in the overplate from migrating into the lining metal beneath. Its presence is important to bearing overplate performance, particularly during the critical period of engine break-in. Maintaining uniform thinness as well as uniform composition of the plated barrier is most important . . . and most difficult to achieve on a production scale. Federal-Mogul research has developed a unique, extraordinarily precise method for controlling both the thinness and the metallic composition of this barrier, within narrow limits. And the performance of F-M engine sleeve bearings attests to the success of the method!

RESEARCH INTO ELECTROPLATING problems is a continuing project in the F-M laboratories. Unusual precision equipment and facilities are employed, many of which have been specially designed and engineered by F-M to solve problems of sliding-bearing application. As a result, Federal-Mogul engineered sleeve bearings, precision thrust washers, formed bushings, and low-cost spacers provide the finest possible performance characteristics for any application.

FEDERAL Mogul



Have you a problem with bearings, bushings or washers? Are you considering the development or redesign of an item of the type shown above? We'll be glad to show you how the job can be done most effectively and economically. For information, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11043 Shoemaker, Detroit 13, Michigan.

FEDERAL-MOGUL

sleeve bearings
bushings-spacers
thrust washers

DIVISION OF
FEDERAL-MOGUL-BOWER
BEARINGS, INC.

INTERSECTING CIRCLES continued

Let $r = 2.0$, $R = 3.0$, $c = 1.75$

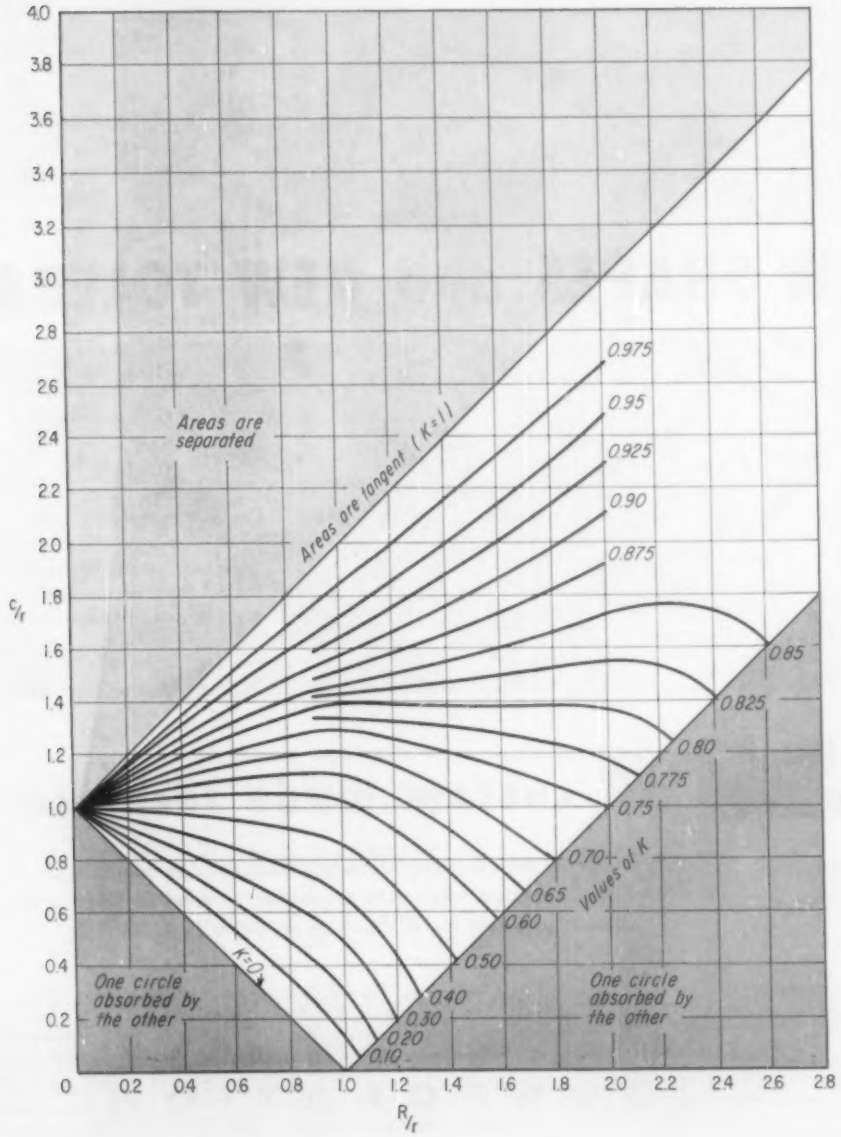
Then, $\frac{c}{r} = \frac{1.75}{2.0} = 0.875$

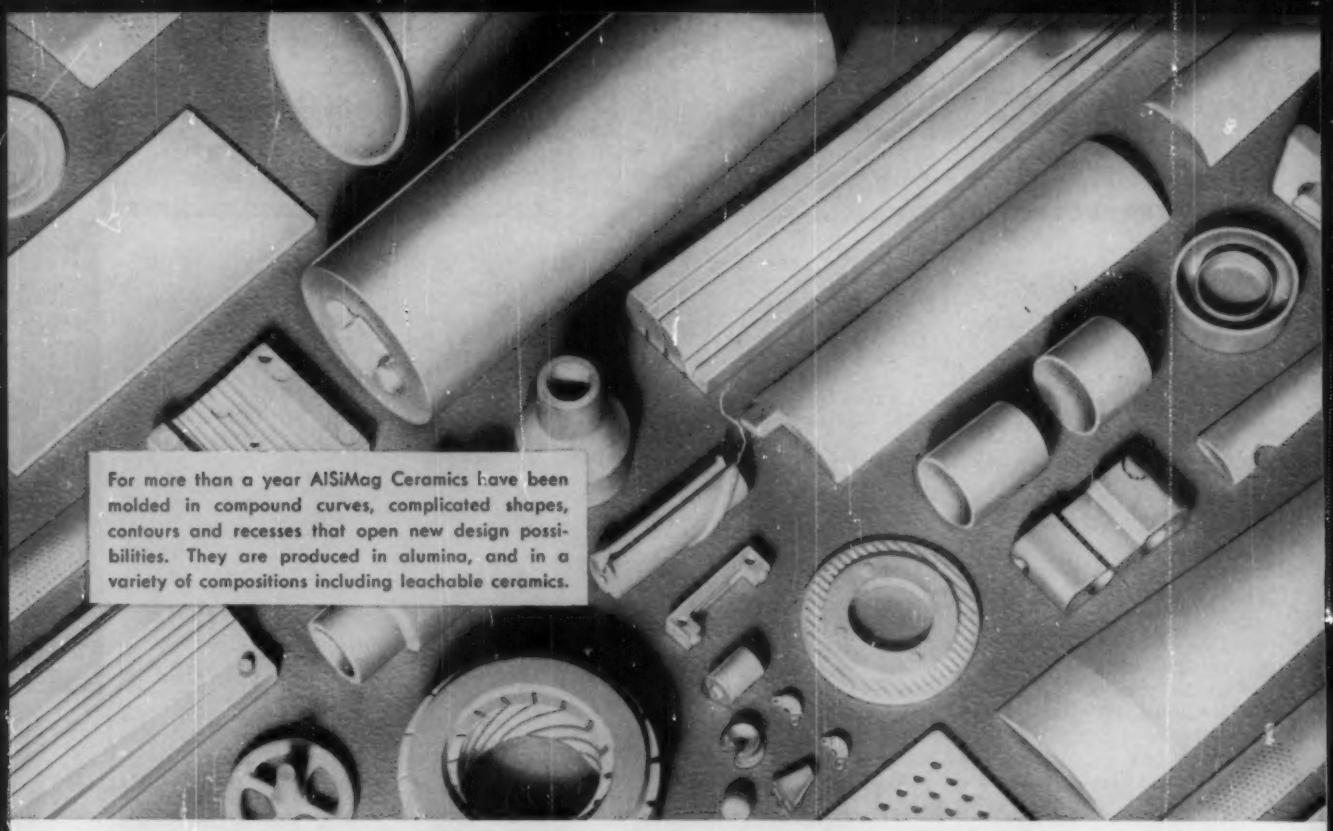
$$\frac{R}{r} = \frac{3}{2} = 1.5$$

From the graph, K approximates 0.66 and

$A_c = (1 - 0.66)\,\pi\,(3)^2 = 9.6$ sq in.

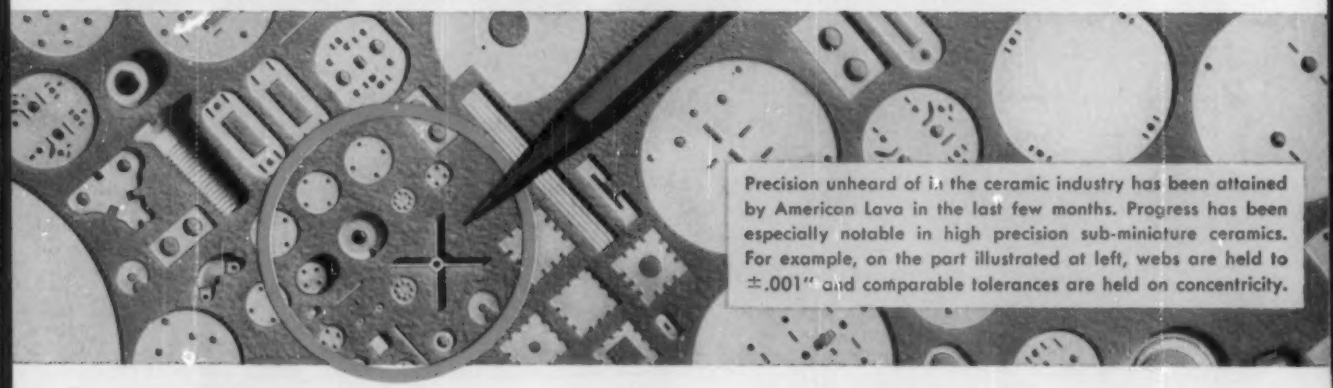
The graph is separated into four regions indicated by shaded and open areas: K's for common areas of intersecting circles fall within the rectangular, central portion. Points falling within upper left portion (outside the rectangle) indicate the circles do not intersect. Along the line, $K = 1$, circles are tangent; points in lower right or left portions indicate one circle is completely within the other. ■





For more than a year AlSiMag Ceramics have been molded in compound curves, complicated shapes, contours and recesses that open new design possibilities. They are produced in alumina, and in a variety of compositions including leachable ceramics.

NEW SHAPES and NEW TOLERANCES in



Precision unheard of in the ceramic industry has been attained by American Lava in the last few months. Progress has been especially notable in high precision sub-miniature ceramics. For example, on the part illustrated at left, webs are held to ±.001" and comparable tolerances are held on concentricity.

ALSIMAG® custom made technical ceramics

Engineers with designs formerly considered too complex or impossible as to dimensional tolerances are invited to send sketches or blue prints. Chances are that NOW they can be made in ALSIMAG.

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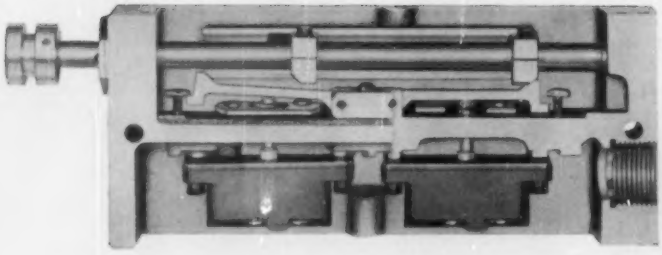
All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

SIGNIFICANT COMPONENTS MATERIALS, PROCESSES

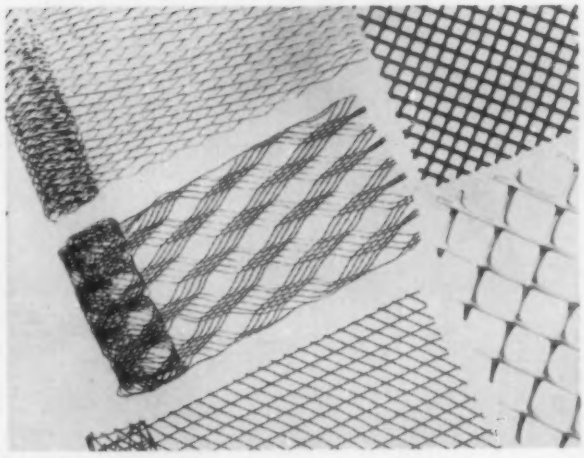


Linear-control packages . . .
control strokes of air and hydraulic cylinders and other linear machine movements; are self-contained units in cast aluminum housings, ready to operate on machine by one rigid mounting of entire unit. Single rod reciprocating with power source through tube actuates switches within housing. Within housing are enclosed reciprocating means for actuating single or multiple numbers of limit switches. Switch cam-actuating means can be preset before final assembly. Available from stock are standard units with reciprocal switch-actuating means in ½- to 4-, 8-, 12- and 18-in. strokes, both in medium- and heavy-duty models. **Paramount Textile Machinery Co, 131 S Wabash Ave, Chicago 3.**

Circle 300 on Reader Service Card

Thermoplastic tubular netting . . .
is manufactured by process that extrudes polymers directly in net form through single operation. By this technique, each strand intersection becomes integral part of material, said to be stronger than individual strands, in contrast to die-cut, interwoven, or heat-sealed netting or tubing where openwork pattern is made after material is extruded. Materials are reported to offer infinite variety in mesh size and pattern, filament diameter, strength, stiffness and color. In addition, they retain chemical and physical characteristics of basic plastic resin. Strand diameters can be made from 15 mil up. Mesh size can be varied from 16 counts to the inch to more than 1 in. between strands. Three basic patterns are available. Now available at $1.50 per lb in tubular or sheeting form for polyethylene netting. **E I DuPont de Nemours & Co, Wilmington, Del.**

Circle 301 on Reader Service Card

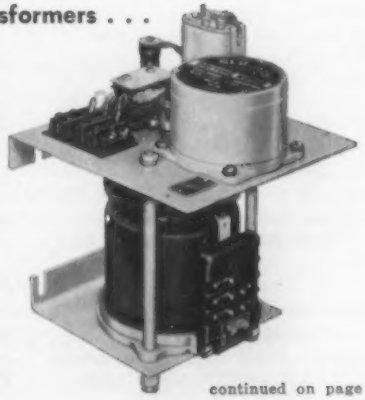


Controlled-acceleration unit . . .
for 1- to 75-hp variable-speed motors provides smooth start to minimize any sudden starts that could damage machine being driven or product. For low initial torque, a reduced torque-control unit is used. To suit varying load conditions and machine applications, starting torque is infinitely adjustable to normal rated torque of motor. After setting control unit for starting torque, compensator unit maintains this same approximate torque from starting to full operating speed. When operating speed is attained, control unit is automatically removed from circuit and motor operates normally. Controlled acceleration unit operates on standard 220/440-v, 60-cps power supply. **US Electrical Motors Inc, Box 2058 Terminal Annex, Los Angeles 54.**

Circle 302 on Reader Service Card

Motor-driven variable transformers . . .
allow more flexible design of systems having loads up to 7.5 kva. Smaller, lower priced assemblies can be used in remotely controlled applications where motor-driven variable transformer is installed in remote space, and pushbutton or raise-lower switch placed wherever desired. Planetary-gear reduction assemblies provide speeds of 5, 15, 30 or 60 sec for full-range travel from zero to max output voltage. **Superior Electric Co, Dept MP, Bristol, Conn.**

Circle 303 on Reader Service Card



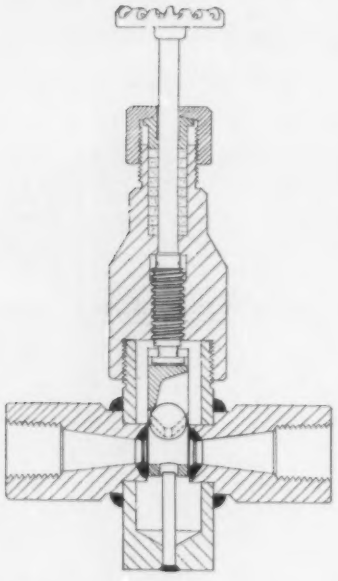
continued on page 86

←CIRCLE 84 ON READER SERVICE CARD

Absolute-pressure transducers . . .

cover range between 0-800 and 0-5000 psia. Offer total static-error brand of 1% max including linearity, hysteresis, resolution, repeatability and friction; and vibration-error band of less than 1.75% at 35 g. Said to provide low friction and high accuracy at high vibrational levels. Bourdon tube transducers are fluid-filled to lubricate mechanism. Fluid viscosity may be adjusted to provide damping of vibrations in any frequency range. Proof pressure is reported to be 150% of rated pressure; burst pressure, 250% of rated. Operating range is −65 through 165 F. Has nominal diameter of 1 in. and is 3½ in. long. **Servonic Instruments Inc, 640 Terminal Way, Costa Mesa, Calif.**

Circle 304 on Reader Service Card



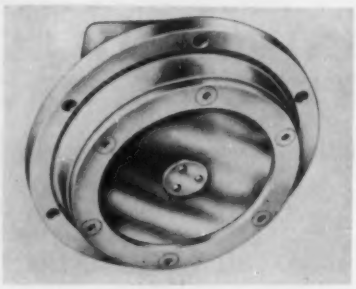
Valve converts from manual . . .

to control valve or motor-operated on-off valve. Conversion is made by replacing bonnet and stem of manual valve with new bonnet and stem and yoke carrying required topworks. Available in ¼, ⅜, ½ and ¾-in. sizes with pressure ratings of 1500 and 2500 lb. Standard construction for manual valve is with inside screw. Automatically operated valves are supplied with interchangeable outside screw and yoke construction. **General Kinetics Corp, 197 S Van Brunt St, Englewood, NJ.**

Circle 305 on Reader Service Card

Hopper-level switch . . .

to control level of material in bins, hoppers or chutes is said to be explosionproof. This 7-in.-dia model mounts directly



through surface of bin. Furnished with one control switch for operating relay or feeding device, and can be equipped with two switches for operating like number of devices, which may be included in process. **Syntron Co, 240 Lexington Ave, Homer City, Penna.**

Circle 306 on Reader Service Card

Special-application generators

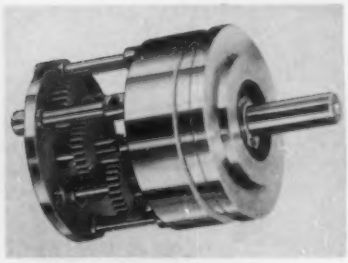
and motor generators are available in ratings from 5 through 100 kw in open-type construction with static exciter-regulators. Inherent regulation is reported to be to ±10% or magnetic amplifier regulation to ±1%. Ac generators with dripproof construction are adaptable for engine mount or direct coupling to driving motor. **Lima Electric Motor Co Inc, Dept 145, Lima, Ohio.**

Circle 307 on Reader Service Card

Stainless pressure controls . . .

operate in ranges of 30-in. vacuum to 75 psi; 10 to 100 psi; 30 to 400 psi; 75 to 800 psi; 100 to 1000 psi. Differentials are available for general-pressure applications, for applications requiring close differentials or where sensitive differentials are needed. Available in general-purpose case NEMA 1, Weatherproof NEMA 2, 3, 4, explosionproof NEMA 7, 9, 9A, (Class I, Groups C and D; Class II, Groups E, F, and G). All parts of control in direct contact with pressure medium are made of 316 stainless steel. Visible calibrated dial indicates exact operating points at which control is set. Hermetically sealed mercury contact, also visible, provides means of determining whether circuit is on or off. **Mercoid Corp, 4201 Belmont Ave, Chicago 41.**

Circle 308 on Reader Service Card



Size-8 gearheads . . .

for servomotors and motor generators are supplied with wide range of reduction ratios. Centered-shaft gearheads are available in 28 ratios, ranging from 7.62:1 to 1254:1 and eccentric-shaft gearheads can be provided in 25 ratios, ranging from 7.62:1 to 903:1. Said to be suitable to military and industrial applications. Shafts may be plain, pinion or of special design. No-load speed range is from 4.7 to 773 rpm min. Min stall torque ranges from 1.8 to 20 in.-oz. Units weigh from 0.7 to 0.9 oz. **Kearfott Div, General Precision Inc, 1150 McBride Ave, Little Falls, NJ.**

Circle 309 on Reader Service Card

Corrosion protection . . .

for brass, brass-plated steel is supplied by a process that involves wetting of metal surface by dip or other means with nonflammable, water-thinnable material. When used as recommended, the protective film shows no rainbow or irridescent effect, no blush and does not alter color of metal. Protected brass-plated steel is reported to have passed 96-hr salt spray exposure test. Suitable for intricately shaped pieces as well as large, flat areas. Processed without use of special equipment and supplied ready for thinning. **Bee Chemical Co, Logo Div, 12933 S Stony Island Ave, Chicago 33.**

Circle 310 on Reader Service Card

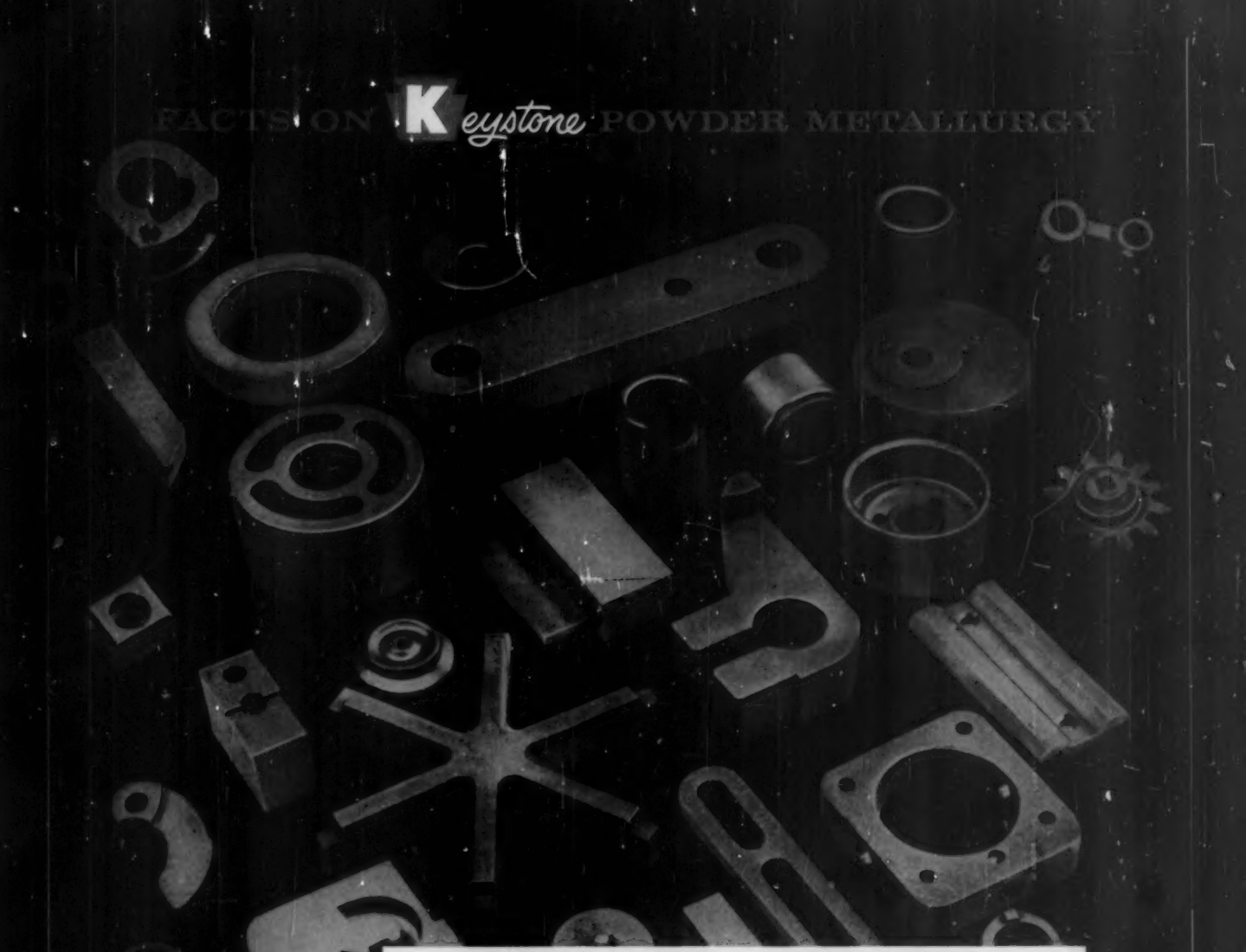
Needle thrust bearing . . .

employs nylon retainer that is said to reduce undesirable sliding friction inherent in all-steel type of needle thrust bearing. Injection molded retainer is also said to have high strength and stability. Thrust capacity of new bearing is reported to be equal to or greater than capacity of all-steel bearing, and permissible operating

continued on page 88

CIRCLE 87 ON READER SERVICE CARD→

FACTS ON Keystone POWDER METALLURGY



—the answers at KEYSTONE have to be RIGHT...

(EVEN WHEN WE HAVE TO SAY NO)

When you come to Keystone with a powder metal production requirement, you can depend upon our response. You'll receive straight answers to questions of design feasibility, tooling economics, choice of materials and finish, physical properties for specified performance, costs per thousand or per million pieces. Our answers to these and many other pertinent questions have to be right for you because they must be correct for us—and we have the know-how of a generation in the business to be sure. ● Occasionally, we must say "no" to a projected application, if unsound for metal powder technology. But we do our best to aid in the re-design that will make production practical, and profit the customer and ourselves. ● Why not sample the Keystone way of doing business, soon? It's made us the leading independent fabricator in the field.

Keystone CARBON COMPANY

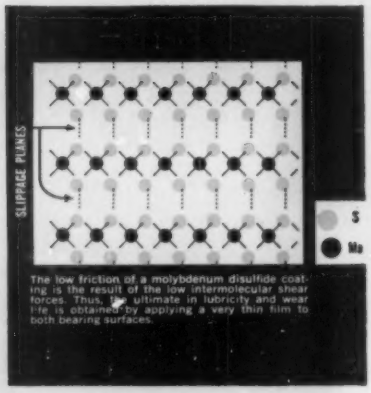
ST. MARYS, PA.

POWDERED METAL PARTS DIVISION

MoS_2+

FORMULA FOR TOMORROW'S LUBRICANT

One-time lubrication . . . permanent, *dry* lubrication . . . applied with the greatest of ease to virtually any type of material—that's just a small part of the amazing story of what Poxylube can do for you.



The low friction of a molybdenum disulfide coating is the result of the low intermolecular shear forces. Thus, the ultimate in lubricity and wear life is obtained by applying a very thin film to both bearing surfaces.

Poxylube replaces conventional greases and oils, does away forever with the need for lubrication, and can be bonded permanently to structural metals, metal products, wood, plastics and glass. Poxylube can be applied by spraying, dipping or brushing, with no surface pre-treatment except degreasing.

Poxylube performs! It supports pressures up to 90,000 psi, operates in temperatures between −100° F. and +500° F., and has a coefficient of friction range of from .025 to .065. It's effective in thicknesses between .0001 and .0004 inch.

How does Poxylube do it? The molybdenum disulfide pigment making up most of the Poxylube film consists of a multitude of flat laminar platelets—40 molecular layers to a millionth of an inch—of alternating molybdenum and sulfur atoms. These layers permit approximately 39 slippage planes to a millionth of an inch . . . thus achieving high film strength and adhesion.

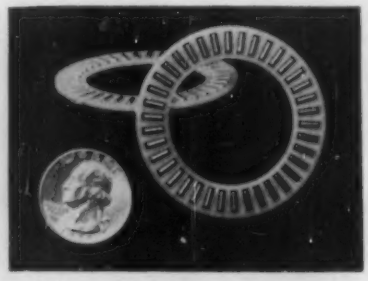
Whether you're lubricating egg-beaters or engines, hinges or helicopters, Poxylube can help you do the job better, permanently, and at less overall cost. Poxylube is currently being used in major missile and space projects. Write for information today.

Pioneering in Industrial Dry Lubricants

POXY LUBE

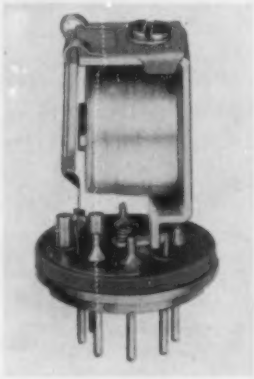
POLY CHEM • 541 South Webster Avenue, Indianapolis 19, Indiana

88 CIRCLE 88 ON READER SERVICE CARD



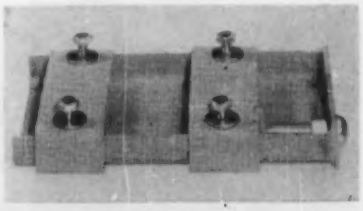
speeds are said to be greater. Bearing is also said to operate at low temperature by having lower heat conductivity and less heat generation. Needle roller diameters have been standardized at 0.078 in. for this line. Can be produced in infinite combinations of bore and OD sizes. Kaydon Engineering Co, McCracken St, Muskegon, Mich.

Circle 311 on Reader Service Card



SPDT relays . . .
in dc models only are available in standard voltages of 6, 12, and 24 v dc and in plate circuit models with 2500, 5000 and 10,000-ohm coils. Voltage-actuated models use nominal power of 180 mw; current-actuated units use nominal power of 40 mw. Dimensions are $1\frac{5}{16}$ x $\frac{3}{4}$ in. dia. List prices range from $7.75 to $8.35. Line Electric Co, 229 River St, Orange, NJ.

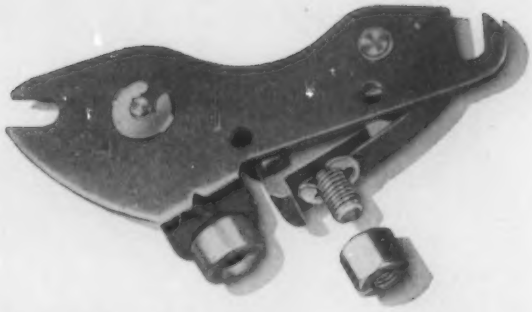
Circle 312 on Reader Service Card

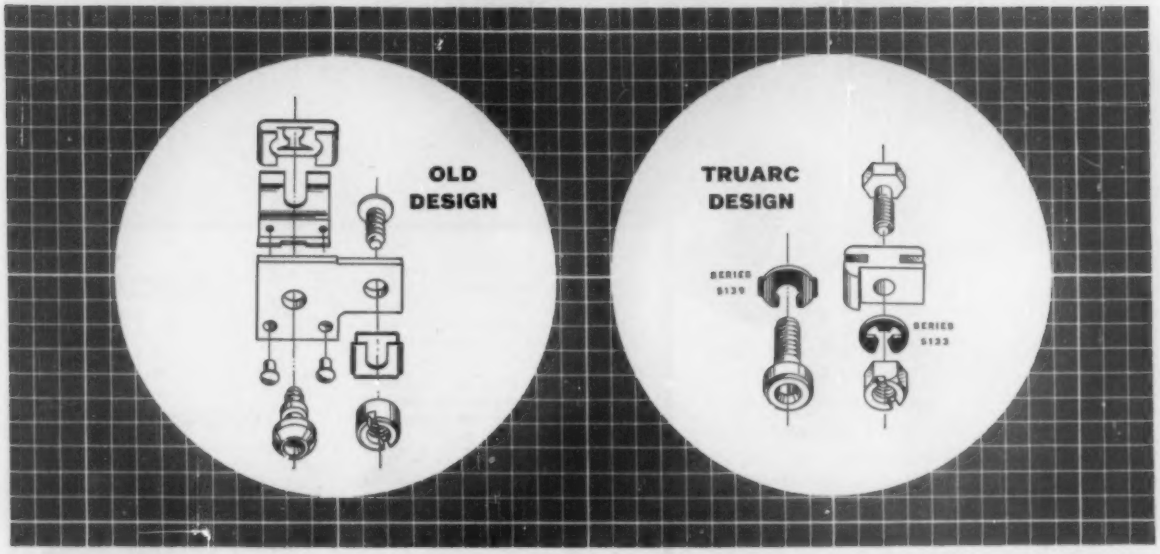


Adjustable motor base . . .
does not lose alignment in loosening or tightening motor belt or removing motor. Consists of simple rail and two tapped

continued on page 92

How Truarc rings simplified design and saved $60 per 1000 units





Look behind this big saving in parts on the auto contact points made by Shurhit Products Inc., Waukegan, Illinois. One Truarc Ring replaced an expensive special purpose fastener. Another eliminated a clip and retaining plate which were 4 times more expensive and difficult to assemble. A third replaced a special purpose nut.

Equally important, besides simplifying and improving design, Shurhit reduced the over-all size of its auto points by ¼" and reduced assembly time by 50%. *Savings: $60 per 1000 units.* Let Truarc Rings help cut your basic manufacturing cost by simplifying design and making assembly faster and easier. Rings often contribute highly saleable compactness as well!

WHY TRUARC RINGS BELONG ON YOUR PRODUCT

They offer a simple and effective way to locate, retain or lock components in place. They fit into grooves inside bores and housings. They work as effectively on shafts or studs (some without grooves).

More than a fastener! Truarc Rings act as a component by replacing machined shoulders, threaded fasteners, rivets and other fastening devices. What's more, they often eliminate threading, tapping, drilling and other machining operations.

Available in 50 types (some with up to 98 sizes), in 6 metals, and 13 finishes—Truarc Retaining Rings can be conveniently ordered from more than 100 stocking points throughout the U. S. A. and Canada.

Read about the impact of Truarc Rings on more than 70 different designs (your product type may be among them) in our Catalog RR 10-58. For *immediate* action call your nearest **Authorized Truarc Distributor.** Look under "Rings, Retaining" in the Classified Telephone Directory. O.1

WALDES TRUARC® RETAINING RINGS

WALDES KOHINOOR, INC.,
47-16 Austel Place, Long Island City 1, N. Y.

9 OUT OF 10 PRODUCTS CAN BE IMPROVED WITH TRUARC RETAINING RINGS

© 1960 WALDES KOHINOOR, INC.

CIRCLE 89 ON READER SERVICE CARD 89

IN WAGNER GEARDRIVES . . .

HIGH-HARDNESS GEARS

provide greater power transmission capacity . . . longer wear life . . . greater resistance to shock

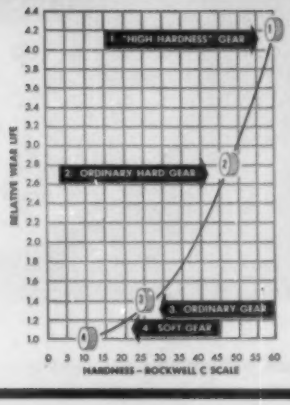
Wagner Gear Drives are built with "High Hardness" gears . . . made from forged blanks of alloy steel, carefully hardened *after* cutting. This special process develops file-hard tooth surfaces with tough, ductile tooth cores . . . maintains close-tolerance accuracy. High strength with high accuracy gives greater capacity, longer wear life than ordinary gears of the same size and weight, plus maximum resistance to shock. Table shows performance comparisons.

1. "High Hardness" gear . . . hardened *after* cutting. Precision processing permits maximum hardness while holding accuracy within extremely close tolerances.

2. Ordinary hard gear . . . hardened after hobbing and shaving. Hardness limited to maintain reasonable accuracy.

3. Ordinary gear . . . hardened before cutting. Hardening limited to maintain machinability.

4. Soft gear . . . excessive size required because of low capacity.

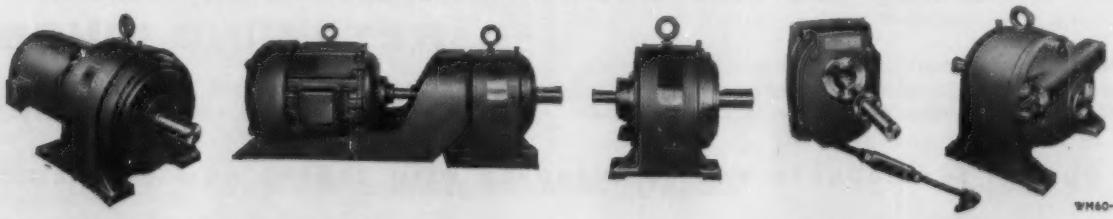


Positive, powerful, slower than motor speeds should mean one thing to you: Wagner Gearmotors. They are built to operate for years at peak efficiency. Advanced design and rugged construction with a minimum number of wearing parts, make this a certainty. Wagner Gearmotors have positive oil seals; continuous lubrication of all moving parts; extra-high capacity bearings; integral bearing housings; and rigid pyramid-mounted cast housings. Extra capacity bearings give them high overhung load ratings, too.

Wagner makes both integral-type and all-motor gearmotors, speed reducers and shaft-mounted speed reducers. They're available in single, double, triple or quadruple reductions . . . horizontal or vertical foot or flange mountings. Another important factor: prompt shipment. Standardized components permit immediate assembly of all standard sizes and types; you get equipment when you need it.

Want to know more? Call your nearby Wagner Sales Engineer; he will be glad to help you select the right drive for your application. Bulletin MU-227 gives full information.

Wagner Electric Corporation 6406 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI



WM60-15

METALLURGICAL RELIABILITY, a function of man and his control of materials and machines. Here at WAIMET we have little that is unique in the world except our dedication to metallurgical science and our unusual ability to tailor alloys to particular end uses. Every day we forge another little wedge, add another small contribution to the knowledge of how metals behave. Here are three alloy improvements that are currently aiding users of high temperature alloys:

17-4 PH

Research, in the field and at home, was the key to improving the reproducibility of 17-4 PH castings. The work of the WAIMET technical team resulted in new guaranteed properties and better knowledge of heat treating requirements.

SUPER 3 and 6

Users of cast abrasion-resistant alloys now have the price advantage (up to 40% lower alloy cost) of WAIMET's new chrome-cobalt-tungsten alloys, SUPER 3 and SUPER 6.

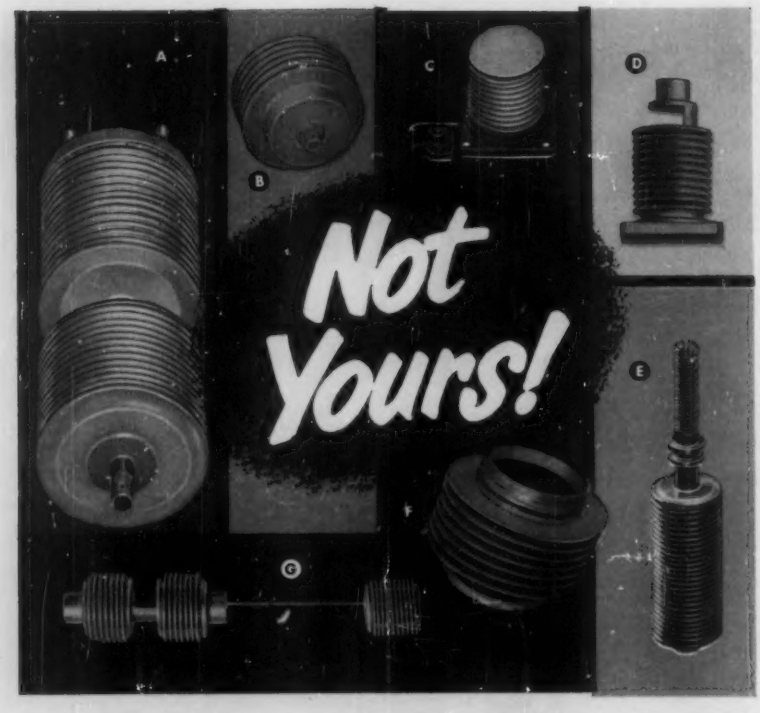
WI-52

In eighteen months of intensive effort, WAIMET brought a promising alloy from its state of marginal reliability up to a degree of reproducible performance not anticipated in the original alloy development.

Do you have alloy casting problems, or casting application problems? Perhaps one of these three outstanding alloys - or others of the RxMET® family of high performance alloys will solve your need. Write us for more information.

WAIMET ALLOYS CO.
5320 OAKMAN BLVD.
DEARBORN 2, MICH.
LUzon 1-7200

CIRCLE 91 ON READER SERVICE CARD 91



If you're a bellows user, odds are high against one of these being yours: they're merely typical of the thousands of different types we've produced for almost every branch of industry.

Name your conditions of stress, atmosphere, temperature, vibration, pressure . . . tell us the flexibility, sensitivity, durability you need.

Backed by the most experienced know-how in the field, every Robertshaw Bellows is custom-engineered to do a particular job . . . and do it more efficiently, more economically.

Get the full story on Robertshaw Bellows and Bellows Assemblies . . . and some good, solid bellows background . . . in Catalog MP-R. FULTON SYLPHON DIVISION, ROBERTSHAW-FULTON CONTROLS CO., KNOXVILLE 1, TENNESSEE.

A. Brass aneroid assembly, ambient pressure compensation. Large bellows for added power and sensitivity.

B. Beryllium copper aneroid assembly for aircraft pressure controls. Highly flexible, durable, sensitive. Silver-brazed construction.

C. Pressure sensitive brass bellows with special end fittings.

D. Brass thin-walled bellows for extreme sensitivity and flexibility.

E. Liquid filled thermostatic assembly; pressure insensitive.

F. Seamless, stainless steel bellows; welding ends. For vibration isolation or misalignment; accommodates pipe movement on sealed systems.

G. Highly flexible brass bellows for aircraft; compensated for ambient pressure changes for absolute pressure response.

Robertshaw

MR. CONTROLS

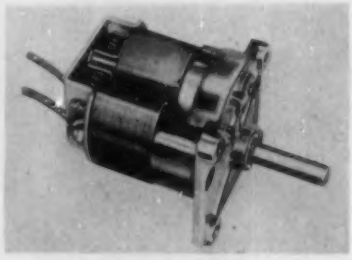
slides that move on rail. Tightening motor belt means loosening jam nut, tightening setscrew and retightening jam nut. Because motor moves on rail, it is said to retain original factory alignment. Model 54 is suited for any NEMA fractional motor base, rigid or resilient. Model 55 handles any NEMA frame 182 through 215. Models are $5 and $11, list, respectively. **Doherty-Silentaire, 3105 Convention St, Baton Rouge, La.**

Circle 313 on Reader Service Card

Photomechanical duplication

produces thin stampings in small or large lots of any sheet material. Make-ready for production of such parts is reported to run as low as 5% of conventional tooling sometimes. Process, at present, is limited from 0.005 to 0.015-in. stock thickness up to max area of 20 x 20 in. Secondary operations can be introduced. **Dayton Rogers Mfg Co, 2824 13th Ave S, Minneapolis 7.**

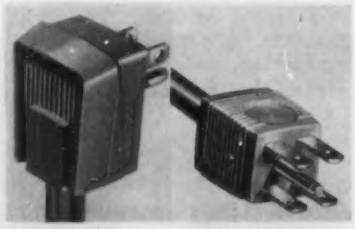
Circle 314 on Reader Service Card



High-torque, low-speed motor

operates from 60-cps power source and delivers 6 in.-lb torque at 20 rpm for 0.75 amp, 115-v input. Delivered for any angular rotation of output shaft. Typical weight is said to be 10 oz. Available in variety of types, supplied for operation at most standard voltage levels. **Airborne Accessories Corp, 1414 Chestnut Ave, Hillside 5, NJ.**

Circle 315 on Reader Service Card



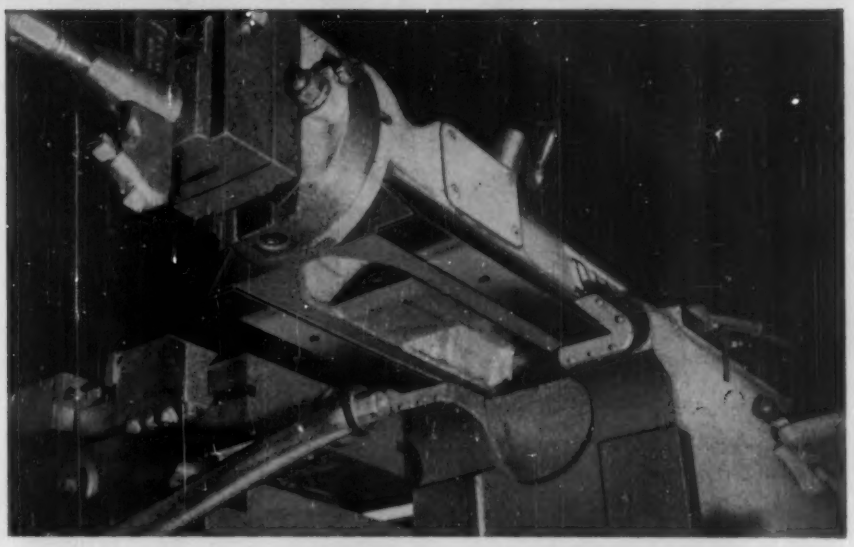
PVC molded plugs . . .

are designed to fit Jones 400 and 2400 series 2- and 4-prong (above right) sockets. The 15-amp, 125-v plugs are produced on custom basis with complete cord set to

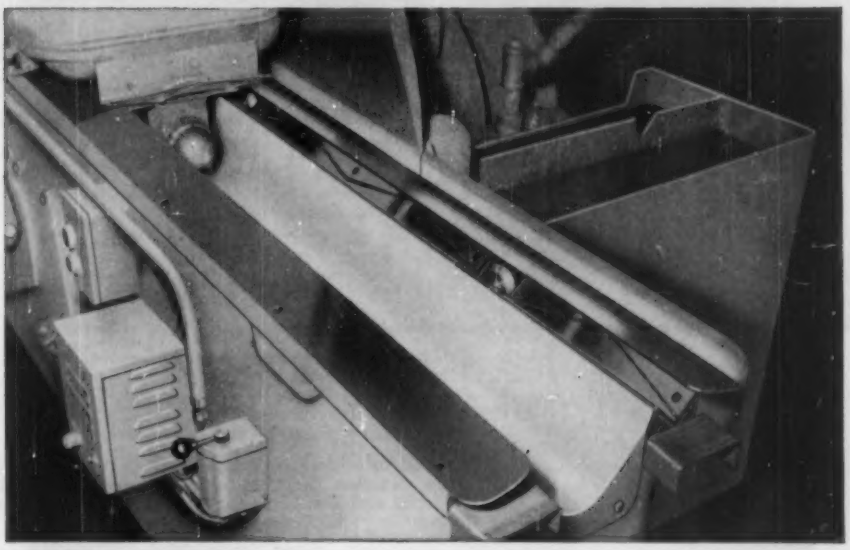
continued on page 96

WEAR PLATES

ANOTHER *Lamina* BRONZE-PLATED PRODUCT



Lamina bronze–plated wear plates used on shaper ways.



Lamina bronze–plated wear plates used on grinder ways.

Lamina bronze-plated wear plates and their many uses are completely described in Bulletin WP-58. Send for your free copy.

Lamina
DIES AND TOOLS, INC.
P.O. BOX 31, ROYAL OAK, MICHIGAN
Phone: JOrdan 6-8711

CIRCLE 93 ON READER SERVICE CARD 93

Big Casting Headache

...solved at the blueprint stage

Does your product face one of these primary causes of corrosion?

- **hydrogen blistering**
- **dezincification**
- **intergranular corrosion**
- **galvanic attack**
- **general corrosion**

These and innumerable other causes of corrosion can be defeated by castings of "created metals". Waukesha's metallurgical staff will derive the *one alloy* to best meet *all* your specifications: weldability, machinability, bearing qualities, durability, resistance to galling and seizing, intricate design, unusual size or shape — and *corrosion resistance!*

Millions of dollars each year . . . up to 25% of total profits! . . . are eaten up by corrosion. This built-in deficit can be stopped at only one point, in the blueprint stage, with castings designed specifically to endure in the environment your product must face.

Waukesha, largest jobbing foundry casting exclusively in high alloy, corrosion-resistant steel, brings five decades of experience with corrosion problems to your casting design. A wealth of metallurgical research and casting experience — as near as your phone.

For engineering counsel on your casting design, metallurgical consultation for your specific corrosion problem, or a casting quotation from your completed blueprints, write or call:

Waukesha Foundry Company

WAUKESHA FOUNDRY CO.

DEPT. NO. F-3 WAUKESHA, WISCONSIN

Manufacturers of corrosion-resistant castings, inclusive of non-galling alloys, Stainless Steel, Waukesha Metal, Monel, Pure Nickel, Inconel, Ni-Resist, plus special Nickel-Chromium Alloys for specific applications.

Alemite Accumite® Centralized Lubrication System avoids costly breakdowns, work-stoppage. Automatic positive lubrication protects all machines!

The Alemite Accumite® Centralized Lubrication System comes complete with pump, metering valves and controls. Meters exact amount of lubricant to all bearings whenever system is operated by air, vacuum or manually at any predetermined frequency.

There's no need for a lubrication shutdown. No chance of work spoilage or bearing failure due to over lubrication. The Alemite Accumite System accurately meters .003, .006 or .009 cu. in. shots of oil or grease automatically. Is available with adjustable fittings for applications requiring measured metering from .003 cu. in. to zero. "Snap-On" and "Screw-In" type valves make for complete flexibility in converting existing systems to automatic operation.

You are assured economical, trouble-free operation of equipment. All bearings are sealed against dirt, grit and water. You are able to eliminate the dangers of neglect because all bearings receive proper lubricant in one, automatic, safe operation!

For complete details on Alemite Accumite® Centralized Lubrication Systems for large or small, stationary and mobile equipment (Canning and Labeling Machines • Tractor Trailers and Lift Trucks • Farm Implements • Machine Tools • Textile Machines • Any Machine or Vehicle with Moving Parts) write for your *FREE* Alemite Accumite Catalog . . . today!

Symbol of SW Excellence

ALEMITE DIVISION
STEWART-WARNER CORPORATION

1850 Diversey Parkway, Chicago, Illinois

Your customers will go for this. S. S. White plastic protectors come off easily and quickly by hand. Save hours of production time. No tools, no prodding, no plying, no tugging. Absolutely non-shredding, too.

Here is low-cost, positive protection for your products during fabrication, storage or shipping. Seal in fluids, seal out dirt, dust, moisture. Prevent blows from damaging vital threads and edges.

Two lines to choose from:

Quality Line... threaded caps and plugs of rigid acetate. The ultimate in toughness, completely resistant to oils or grease.

Economy Line... elastic vinyl for non-slip grip. Easy-on, easy off, yet a stay-put fit.

WRITE FOR FREE BULLETIN
P5708 and Samples

1115

S.Silbhite **PLASTICS DIVISION**
Dept. 14P, 10 East 40th Street, New York 16, N.Y.

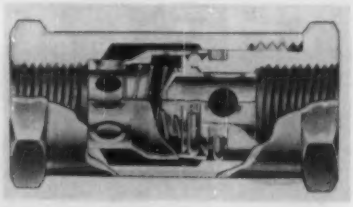
customer specifications. Also available is heavy-duty, right-angle plug (above left) that is molded in one piece of vinyl plastic and bonds to cord insulation. Vinyl plastic cord sets are also produced to customer specifications. Available on three-wire power supply cords for electrical and electronic equipment, machinery and appliances. **Miller Electric Co, 120 Main St, Pawtucket, RI.**

Circle 316 on Reader Service Card

Chemical sizing . . .

permits use of less-expensive steel for critical aircraft and missile structures by bringing steel into tolerance at specific gage. Process is said to be applicable to most metals and alloys presently being chemically milled. Chemical sizing is not only used to produce precision-weight chemically milled parts, it has also become a means of producing close-tolerance stock for fabrication by other methods. Hot-rolled stainless steel, previously considered unusable because of poor surface conditions, is now being resurfaced by the process to eliminate pits and scale, and to provide aircraft-quality tolerances. Process makes available sheet and plate material in any standard or nonstandard gage and in any size or quantity with thickness tolerance as close as 1% of thickness. **Anadite Inc, 10630 Sessler St, South Gate, Calif.**

Circle 317 on Reader Service Card



Checkvalve . . .

has cage device that restrains O-ring from washout. Dead-tight sealing and chatter-free operation are said to result from design. Valve is reported to offer proper cushioning combined with low pressure drip and sensitive, leak-free reseating. Bodies of brass, aluminum, steel and stainless steel are available, and range from ⅛ to 2 in. pipe size. Suitable for use in wide variety of high-pressure gas or liquid services where extreme surge flows are encountered. **Circle Seal Products Co Inc, 2181 E Foothill Blvd, Pasadena, Calif.**

Circle 318 on Reader Service Card

Small-volume regulators . . .

are said to handle wide range of pressures with high accuracy. All metal parts in contact with line fluid are stainless steel,

continued on page 100

ECONOMY, DURABILITY AND DEPENDABILITY are outstanding characteristics of these sintered metal gears. Parts like these are the result of close cooperation between Delco Moraine and its customers from idea through design and development to production.

DELCO MORAINE

DEPENDABLY MADE parts for industrial progress • Division of General Motors, Dayton, Ohio

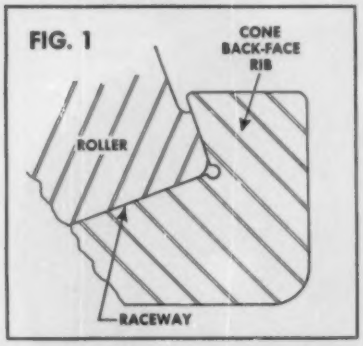
BEARING BRIEFINGS

BEARING GEOMETRY MAKES OR BREAKS BEARING PERFORMANCE

To develop high capacity and optimum performance in a tapered roller bearing, it is essential that roller alignment be accurate. Correct roller alignment, in turn, depends on a critical geometric relationship between the cone back-face rib, and the cone raceway.

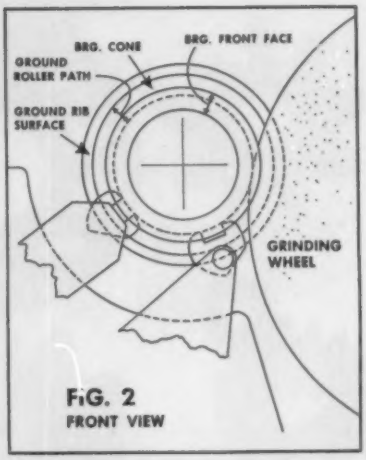
Perfection in this geometric relationship compels the rollers to align themselves perfectly with respect to the bearing geometry, and each roller shares equally in the work that is imposed. Figure 1 diagrams the important elements involved.

When this rib-to-raceway relationship is incorrect (because of either faulty bearing design or manufacturing inaccuracies), rollers experience misalignment and begin to skid and skew under



load. As engineers know, poor performance and premature bearing failure are inevitable under these conditions.

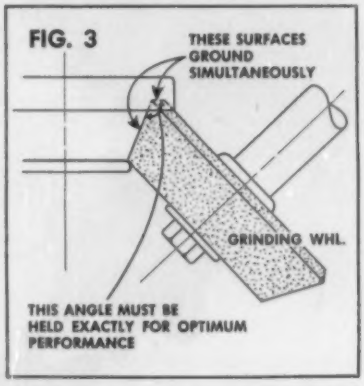
In the design and manufacture of Bower tapered roller bearings, Bower engineers take great care to generate and hold an exact face angle on the cone back-face rib. In practice, this means that Bower



bearings are designed for maximum life and optimum performance under any operating conditions. It means that Bower bearings retain accurate roller alignment under all speeds and loads up to the maximum for which the bearing is rated.

It's one thing to develop proper bearing design on paper, but quite another to carry it out consistently in manufacture. To this end, Bower engineers were instrumental in the design and development of a unique centerless grinder on which Bower precision grinds each bearing's cone raceway and rib-face simultaneously. The results obtained from these machines invariably meet or surpass Bower's exacting requirements and assure perfect roller alignment.

Figures 2 and 3 are front and top views which illustrate Bower's technique of centerless grinding rib-faces and cone raceways together. As a result, every component in a Bower bearing is perfectly concentric about its rolling axis.

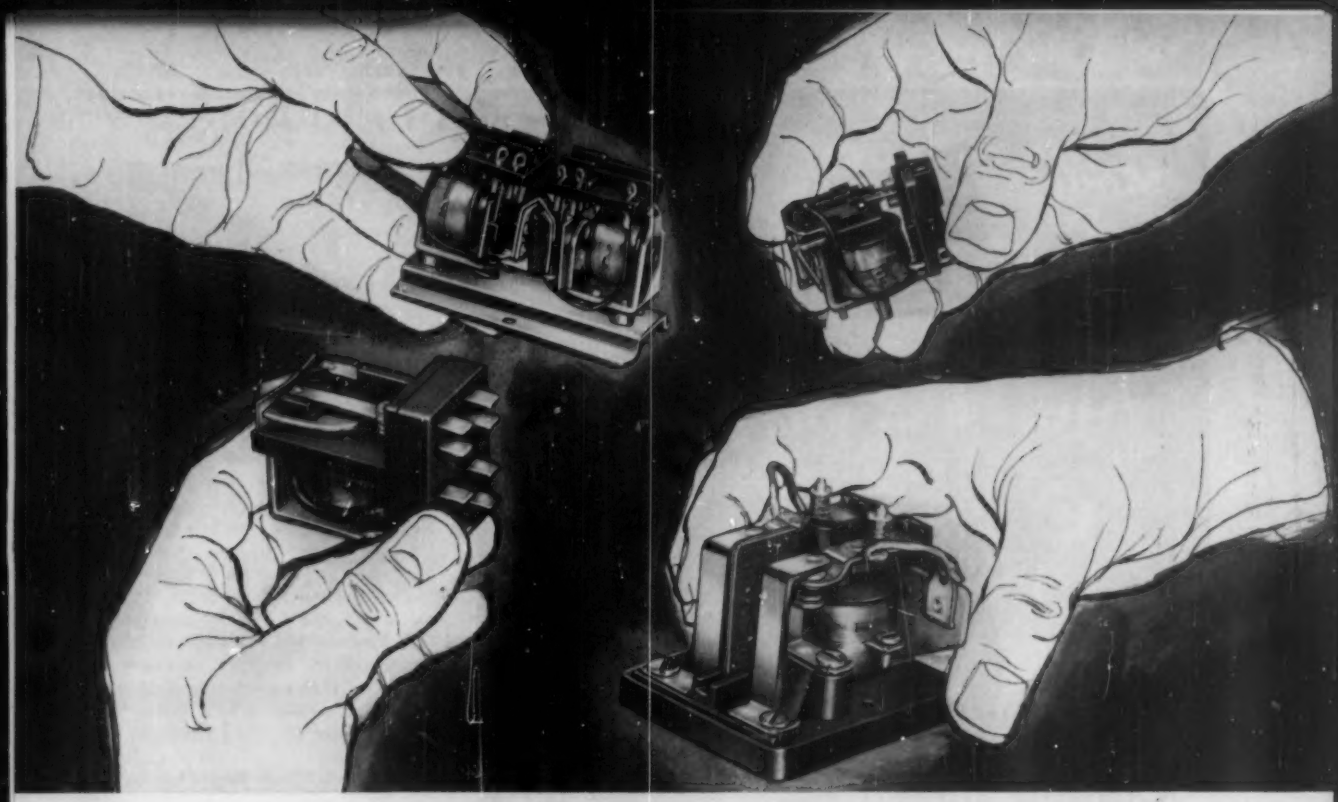


★ ★ ★ ★

When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION – FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN



save time! save money! call your parts distributor for P&B RELAYS

These important savings are yours when you order—from your Electronic Parts Distributor—P&B relays listed with Underwriters' Laboratories, Inc. and Canadian Standards Association:

SAVE TIME. You get fast, off-the-shelf delivery. Usually your order is shipped the day after it is received. And no waiting for U/L or CSA clearance . . . this has been done for you. Thus you get your project—and your product—off to a fast start!

SAVE MONEY. You save the cost of getting relays listed with U/L or CSA . . . and you need have no big investment in shelf inventory, either. Remember, you pay no premium over factory prices in quantities to 249.

More than 40 different standard P&B relays in 450 different coil voltages and contact arrangements are available from the leading Electronic Part Distributors in your area. For special applications, call your nearest P&B sales engineer.

PR Series

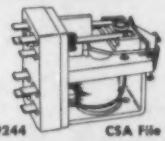
Type	Contact Arrangement*	Type	Contact Arrangement*
PR1AY	SPST-NO	PR5AY	SPDT
PR3AY	SPDT-NO-DM	PR7AY	DPST-NO
		PR11AY	DPDT

These relays are available in any of the following operating voltages: 6, 12, 24, 115, 230 volts 50/60 cycles AC.

Contacts are rated at: 25 amps, 115/230 V. AC 1 phase. 1 hp for 115/230 volt AC motors 1 phase.

*Read: NO normally open, NC normally closed, DB double break, DM double make.

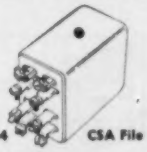
U/L File E22575 CSA File 15734



AB Series

U/L File E29244 CSA File 15734

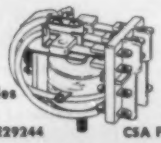
For appliance and general purpose operations requiring long life and quiet operation. Quick connect terminals. Screw terminal adapters also furnished with each relay. Contact arrangement: DPDT. Rated at 10 amps, 115 V., 5 amps, 230 AC non-inductive by U/L and CSA.



ABC Series

U/L File E29244 CSA File 15734

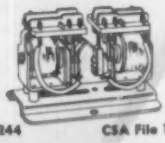
Medium duty power relay in dust cover. For small motors, industrial controls and similar applications. Contact arrangement: DPDT. Rated at 10 amps, 115 V., 5 amps, 230 AC non-inductive by U/L and CSA.



KA Series

U/L File E29244 CSA File 15734

Small, low cost, general purpose relay for handling automation work, small motors, solenoids, other relays. Contact arrangements: SPDT, DPDT and 3PDT. Rated at 5 amps, at 115 V., AC non-inductive by U/L and CSA.



KB Series

U/L File E29244 CSA File 15734

Compact latch relay ideal for memory work and overload applications. Operates on momentary impulse to either coil. Contact arrangements: 4PDT and 6PDT. Rated at 5 amps at 115 V., AC non-inductive by U/L and CSA.

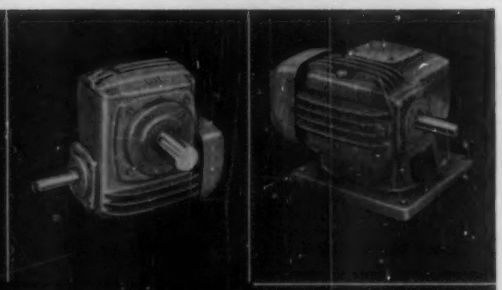
POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

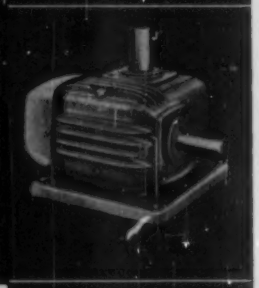
IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

CIRCLE 99 ON READER SERVICE CARD

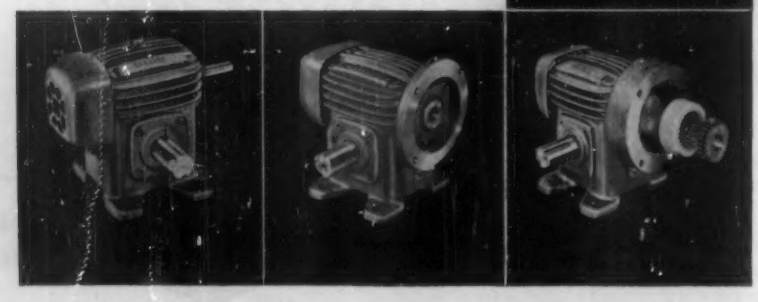
A Model For Every Job



THE NEW OHIO LINE



A Complete Line Of Fin And Fan Cooled Speed Reducers



80% MORE CAPACITY

Hi-Line reducers let you handle bigger loads — at far less cost than conventional reducers.

25% LESS SPACE

Hi-Line reducers are smaller—let you save space without sacrificing capacity or service life.

...WITH A MODEL FOR EVERY JOB

Only a representative group of the more than 100 Hi-Line models are shown here. There are six series with center-distances from 1.33″ to 5.25″ with input capacities from 1/16th to 18 h.p. They can be provided with or without fan cooling and most models are available with "C" flange motor mounts.

IMMEDIATE SHIPMENT FROM LOCAL STOCK

Write for the free Hi-Line Catalog — 65 pages of engineering and dimensional data.

Ohio Gear Distributors stock a complete line of gears and speed reducers

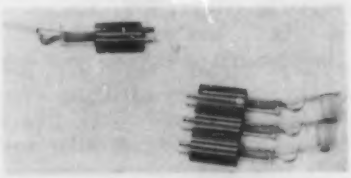
Ohio

including filter. Single screw adjusts sensitivity range of downstream relief function. Gear reductions to minimize handwheel turning effort are standard on some models, optional on others. Most basic parts and assemblies are interchangeable between models. Available in ¼- and ⅜-in. sizes, inlet pressure-capacity range to 10,000 psi and for various controlled or reduced pressures to max of 6000 psi. Regulators are also available for back-pressure control and as relief valves. Broadest use is expected to be for mounting in test benches and consoles to control static pressure. However, regulators will also be suitable for other types of static, mobile and airborne service. **Grove Valve and Regulator Co, 6529 Hollis St, Oakland, Calif.**

Circle 319 on Reader Service Card

Square-frame dc motor . . . is rated 4 hp at 8500 rpm continuous duty; 6 hp at 7300 rpm intermittent duty. Originally designed to drive high-altitude missile pump, motor is adaptable to wide range of industrial applications, such as actuators, blowers and pumps. Offers integral cooling fan, thermal overload protection, high-temperature windings and insulation. Flame-quench rings provide explosionproof construction to MIL-E-5272A, Procedure 2. Operates on 26.6 v dc. Measures 10.94 x 5 x 6.4 in. Weighs 18 lb with radio noise filter. **Hoover Electric Co, Hangar 2, Port Columbus, Columbus 19, Ohio.**

Circle 320 on Reader Service Card



Miniature snap switch . . . with wiping action is available as single or double throw, set or return type in up to four poles. Said to be thinnest switch in its field, with two and three pole stackups in narrow space. Single and double pole switches are rated 125 v ac, 5 amps; 250 v ac, 2.5 amp. Single-pole switch requires 28 gm max operating force and 10 gm min release force on return type. Double-pole switch requires 56 gm

continued on page 102

Announcing

NEW

Norgren

COMPRESSED AIR LINE FILTERS

for ¼", ⅜" and ½" pipe sizes

The most efficient filter you can buy...
the easiest to service

1 **100% liquid removal—**
Improved Norgren design provides a greater than ever liquid removal efficiency. Over the entire range of recommended air flow, this filter effectively traps all liquids.

2 **Easier and quicker to service—**
No tools needed and only 4 separate parts to handle.

3 **Larger bowl capacity for collected liquid—**
The "quiet zone" below the baffle holds 53% more collected air-line contaminants. Requires less frequent draining.

4 **New improved bowl—**
New, stronger transparent bowl has greatly improved resistance to fatigue failure.

PLUS *these important benefits:*

- **Highly effective removal of solids.**
- **Optional interchangeable filter elements—** 74, 64, 25 or 5 micron.
- **Reduced service time**—the simplest, easiest filter to disassemble and clean.

Where protection for transparent bowls is required,
a metal bowl guard, held in place by the clamp ring, is available.

For complete information about Norgren's complete line of manual drain and automatic-drain compressed air line filters, call your nearby Norgren Representative, listed in your telephone directory—or WRITE FOR BROCHURE NA-1.

FOUNDED IN 1926

C. A. NORGREN CO.

3428 SOUTH ELATI STREET • ENGLEWOOD, COLORADO

CIRCLE 101 ON READER SERVICE CARD 101

Design Uniform lift into equipment with DUFF-NORTON WORM GEAR JACKS

Many designers find a ready answer to precise control of linear motion in machinery or equipment with built-in Duff-Norton Worm Gear Jacks.

They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66DD.

DUFF-NORTON COMPANY

Four Gateway Center • Pittsburgh 22, Pa.

COFFING HOIST DIVISION • Pittsburgh, Pa.

DUFF-NORTON JACKS
Ratchet • Screw
Hydraulic • Worm Gear

DUFF-NORTON

COFFING HOISTS
Ratchet Lever • Air
Hand Chain • Electric

max operating force and 20 gm min release force on return type. Columbus Electric Mfg Co, 2005 E Main, Columbus, Ohio.

Circle 321 on Reader Service Card

Injection oiler . . .

is for use with low-volume short-stroke air cylinders. Installed in pressure line between control valve and cylinder, injection oiler delivers a controlled amount of oil direct to cylinder through capillary tube within cylinder air-supply line. Oil is supplied to injection oiler either from standard lubricator placed ahead of control valve or from small oil reservoir under pressure. Also available in kit form with necessary fittings and tubing. Watts Regulator Co, Industrial Div, Embankment Rd, Lawrence, Mass.

Circle 322 on Reader Service Card

Flow-actuated switch . . .

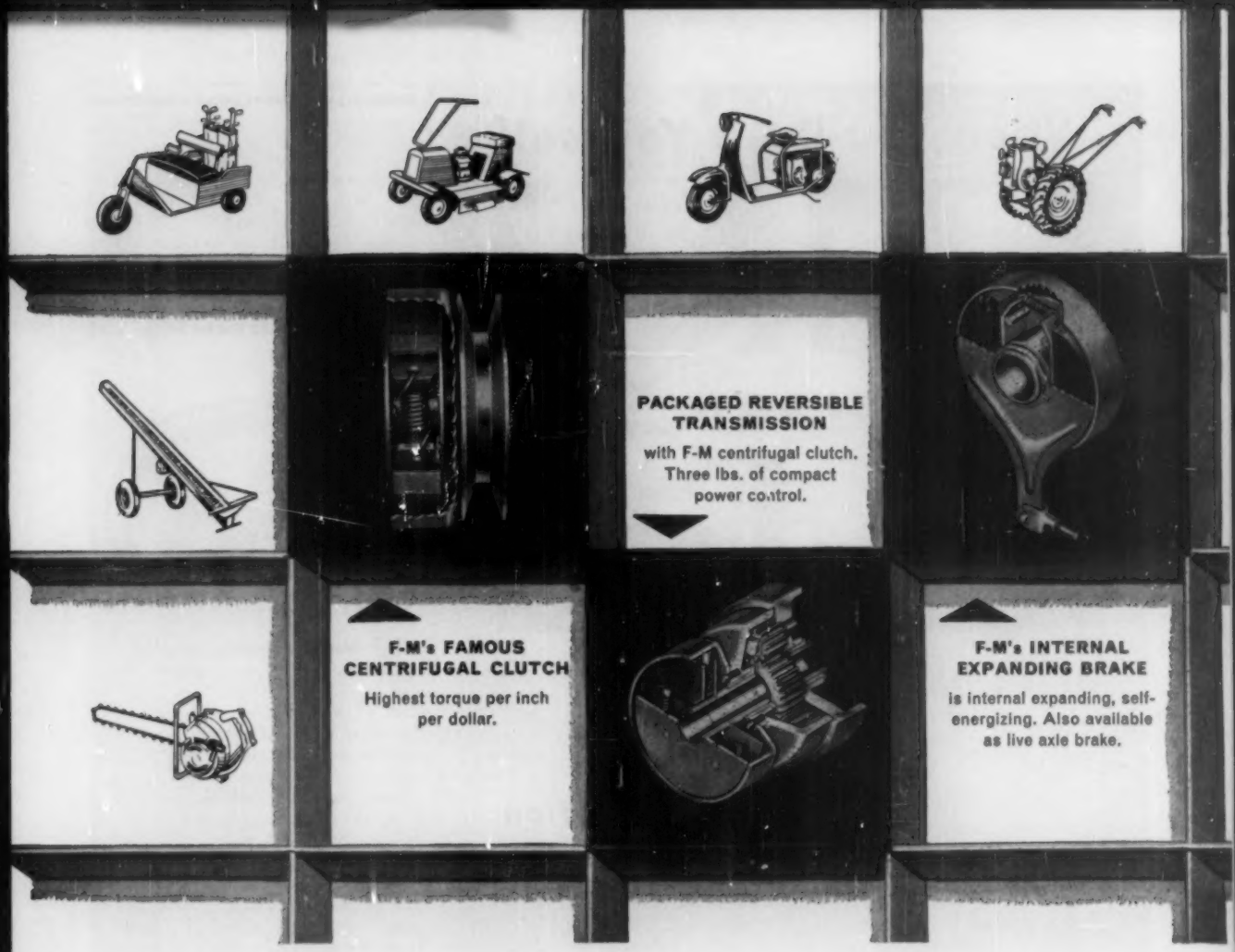
starts and stops pumps, valves, alarms, signals or controls. Made to fit lines from ¼ to 60 in. in brass, bronze, steel and stainless steel, with variety of electrical switching arrangements and capacities. Switches are leakproof and do not use packing glands or stuffing boxes. Said to meet or exceed all safety requirements for protection of products and equipment against undesirable increase, decrease, reversing or loss of low. Power Equipment and Engineering Co Inc, 1826 213th St, Torrance, Calif.

Circle 323 on Reader Service Card

Solenoid actuator . . .

is available with both push and pull linkages and has application in reciprocating motion, vibration generators, rotary step motion, model actuators, remote switches, valve actuators, computors and automated equipment. Utilizes linkage system that magnifies original air-gap movement in 8:1 ratio. Life is reported at 100 million operations. Capable of 7-millisec operat-

continued on page 104


PACKAGED REVERSIBLE TRANSMISSION
with F-M centrifugal clutch. Three lbs. of compact power control.
F-M's FAMOUS CENTRIFUGAL CLUTCH
Highest torque per inch per dollar.
F-M's INTERNAL EXPANDING BRAKE
is internal expanding, self-energizing. Also available as live axle brake.

Control Small Engine Power

WITH THIS THRIFTY THREESOME!

Here's a space-saving, thrifty threesome that starts, stops, idles or reverses standard small gasoline engines or motors in many types of original equipment such as power mowers, saws, lawn sweepers, portable elevators and golf carts. Often they make it possible for designers to specify less expensive, lower hp power units, too!

PACKAGED REVERSIBLE TRANSMISSION for 1½ to 5 hp use. Only 4" long, less than 5" diam., it mounts on engine or motor shaft extension or may be used as auxiliary drive. Eliminates gear shifting levers, belt tighteners. Includes the famous F-M automatic clutch as follows:

AUTOMATIC CENTRIFUGAL CLUTCH produces up to 50 lb. ft. at 3600 rpm. Three standard types, extremely compact, adapt easily to pulleys, sprockets, gear or coupling drives. Free-wheeling. Overload-protected. Adjusts to engage smoothly at desired speed as load accelerates. Available separately or as integral part of F-M packaged reversible transmission

INTERNAL EXPANDING BRAKE, very compact, self-energizing, for small power tools, vehicles. Stationary or live axle types. Available in 3½" and 5" sizes.

Chances are excellent that one or more of this space-saving thrifty threesome can save you both in dollars and simplified design in 1½ to 5 hp applications.

Get the facts . . . today. Write to: Fairbanks, Morse & Co., Magneto and Engine Accessories Division, Beloit, Wisconsin.

Fairbanks, Morse

MAGNETO AND ENGINE ACCESSORIES DIVISION

A MAJOR INDUSTRIAL COMPONENT OF FAIRBANKS WHITNEY CORPORATION

CIRCLE 103 ON READER SERVICE CARD

When You Do It Yourself

start with CHEMLON®

The Best In Teflon

It's a matter of good precaution—Getting the full advantages of this material depends largely on the processing ability of your supplier. He must meet *all* of these qualifications:

1 Fabricating experience, facilities and rigid quality control to supply a uniform, non-porous Teflon, free from any flaws, thus eliminating costly rejects or malfunction of your end product.

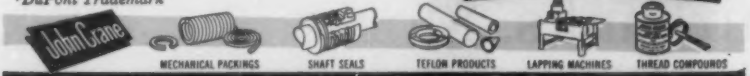
2 Dimensional accuracy—no matter what form you order, it should be carefully sized to industry specifications. Any waste of Teflon adds substantially to its cost, and corrective finishing in your own shop unnecessarily adds production time and expense.

Under the name, Chemlon, "John Crane" gives you full satisfaction on each of these points, plus engineering assistance on any problem you might have.

Contact "John Crane" about your specific needs. Also ask for Bulletins T-110 and T-122.

Crane Packing Co., 6445 Oakton Street, Morton Grove, Illinois, *(Chicago Suburb)*
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

*DuPont Trademark



CRANE PACKING COMPANY
OFFICES IN ALL PRINCIPAL CITIES

ing time at normal voltages. May be set for push or pull by reversing position of arm. Max stroke is 0.125 in., exerting pull of 100 to 550 grams. Off-the-shelf units include 6-, 12-, 24- and 48-v models with voltages from 6 to 148 v dc available on order. **James Cunningham Son & Co Inc, 103 Litchfield St, Rochester 8, NY.**

Circle 324 on Reader Service Card

High-temperature ring seal . . . is nonsplit, hydraulic and pneumatic linear-motion ring seal for use from —425 to 1500 F. All-metal seal comprises a metal lip of special configuration fastened in stainless steel ring. Ring supports lip in axial direction and prevents blowout under extreme pressures. Seals are reported to have been tested under hydraulic pressures in excess of 20,000 psi without showing leakage or other ill effects. Compatible with practically all hydraulic fluids and gaseous media. Available in standard and double-unit series, each in 37 standard sizes, in bore diameters from ½ to 7 in. **Gits Bros Mfg Co, 1866 S Kilbourn Ave, Chicago 23.**

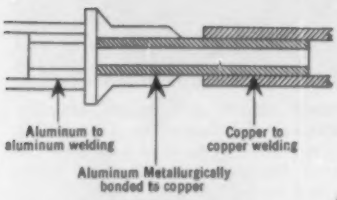
Circle 325 on Reader Service Card

Electrical integrator . . . for precise integrating of flows or any other quantity that can be linearly represented by dc voltage or current signal in 0-25 v range. This could include positive displacement fluid motors driving tachometers, lineal measurement of webs and strips. Integration is continuous and said

continued on page 108

CREATING NEW SOLUTIONS TO NEW PROBLEMS | GENERAL PLATE CLAD METALS

One of series illustrating how General Plate Clad Metals help uncover new horizons in one of many fields of engineering accomplishments: REFRIGERATION



ALCUPLATE® (aluminum clad copper) fabricated into tubing connector solves mechanical joining problem. Aluminum and copper are metallurgically bonded and permit aluminum to aluminum and copper to copper welding for a corrosion-free seal.

New Products made with New Materials... New Processes...

USED IN NEW AND DIFFERENT WAYS

Among the important contributions to the success of refrigeration is the use of ALCUPLATE® (aluminum clad copper) fabricated into a tubing connector. In this small part composed of clad metal, the advantages of welding copper to copper and aluminum to aluminum are combined to create a perfect corrosion-free seal. This makes it possible to eliminate galvanic corrosion and subsequent leakage resulting from bonding copper and aluminum tubing using cold welding techniques.

General Plate Alcuplate is but one of over 400 different combinations of clad metals available which are finding wide use in industry after industry. New combinations are being developed constantly.

No matter what your metal problem, it will pay you to consult with Metals & Controls Division Engineers. Their vast experience in cladding precious to base or base to base metals can overcome your metals engineering problems with multiple property requirements . . . often reduce costs, too. Write today.

TEXAS INSTRUMENTS
INCORPORATED
METALS & CONTROLS DIVISION
1006 FOREST STREET • ATTLEBORO, MASS.

General Plate Products: Clad Metals • Electrical Contacts • Truflex® —Thermostat Metal • Gold, Silver, Platinum and other Precious Metal Products

To OEM's who want to reduce the size of their control panels

The small size of General Electric panel components offers OEM's the opportunity to reduce the size of their panels up to 40%. Consider these two examples:

Example 1: Suppose you lay out a panel—including several size 1 or 2 starters or contactors—and the devices you choose fill up 900 square inches of space. To meet JIC standards, you must then enlarge your panel to 1170 square inches (adding 30% of clear panel mounting space). Because General Electric starters and contactors in these sizes are from 10 to 50% smaller than those of major control suppliers, you can avoid enlarging your panel beyond 900 square inches by using G-E devices. And you can still meet the standards and save on the sheet metal and labor required for a larger panel.

Example 2: If you build motor control centers in 7-, 9¼-, and 14-inch modules, you can stack General Electric size 2 starters eight compartments high. (This compares to five for most leading control manufacturers.) Thus you can save in steel work and up to 40% in the user's floor space.

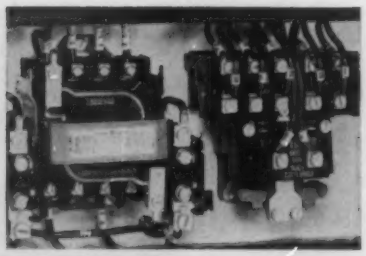
Similar advantages of small size, minimum wiring time, mounting convenience, and fast delivery are available with not only starters and contactors but also with General Electric relays, pneumatic timers, and push buttons. You can get *some* of these advantages from other manufacturers of panel components, but General Electric offers *all* these measurable advantages — and the greatest over-all savings to you.

For more information, contact your General Electric Apparatus Sales Office or request bulletins GEA-7020 (magnetic starters), GEA-7021 (relays), and GEA-5779 (oil-tight push buttons) from General Electric Company, Section 811-09, Schenectady 5, N. Y.

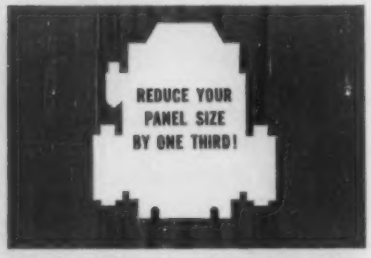
You get **MEASURABLE ADVANTAGES WITH GENERAL ELECTRIC CONTROL**

Progress Is Our Most Important Product

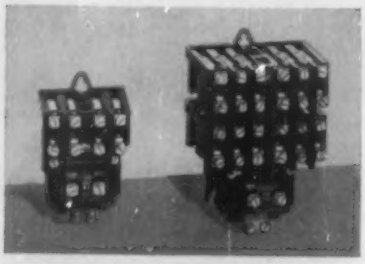
GENERAL ELECTRIC



SIZES 0 AND 1 STARTERS are 42% smaller than previous forms and about the same height as G-E 4- and 6-pole machine tool relays. Straight-through wiring means no looping of wiring around sides; only ½-inch side spacing required between starters.



SIZE 2 STARTERS are 34% smaller than previous forms; can reduce your panel space by 1/3. Wiring, coil, contacts, and overload relays are all accessible and removable from the front, eliminating need for extra space around the device.



COMPACT RELAYS save space, simplify installation and inspection. Less wiring room is needed because all terminals are in front. Machine tool relays are available in 2- through 12-pole forms.

2-IN-1 ILLUMINATED PUSH BUTTON replaces standard oil-tight button and light. This means a saving in money and a measurable 50% saving in space.

You get Cast Bronze Bearings with a Pedigree from Johnson Bronze

Bearings with a *pedigree*—rigidly controlled quality from ingot to mold to finished part—that's what you get when you buy cast bronze bearings from Johnson Bronze Co.

Johnson's 59-year record of consistently supplying *pedigreed* bearings has built a reputation for being "accepted on sight." Close alloy and dimensional control make your inspection easy. The *pedigree* of these bearings tells you why.

So why not put more quality into your product with Johnson cast bronze bearings? Call, write or wire Johnson Bronze. Put the *pedigreed* bearings to work for you.

Johnson Bronze Company

New Castle, Pa.

West Coast Plant: Oakland 8, Calif.

CIRCLE 107 ON READER SERVICE CARD 107

Baldor Motor specially-designed for the Southwestern Engineering Co., Los Angeles. This motor, with eccentric weight on both ends of shaft, is the drive mechanism for their efficient SWECO Vibro-Screen Separator.

Another version of same motor designed by Baldor to fit a specific application. Result is a highly efficient power-plant that keeps equipment operating with a minimum of downtime.

Let BALDOR'S unique engineering service design the one right motor for your equipment!

To assure maximum efficiency from today's highly complex and precision-built equipment, more than just a standard-type motor is needed to supply the power. It has to be designed and engineered to fit the specific application—not just *adapted* to the equipment.

Baldor's staff of extremely competent engineers has played an important part in helping many original equipment manufacturers develop motors that are "tailor-made" for their particular requirements.

This outstanding design and engineering service is yours without delay or obligation. Contact your local Baldor representative or write direct.

Our 40th Year!

Baldor Electric Company

4351 Duncan Ave. • St. Louis 10, Mo.

Over 500 Authorized Sales & Service Distributors in U. S. A.

District Offices: Atlanta • Chicago • Cleveland • Dallas • Dayton Des Moines • Detroit • Litchfield, Conn. • Los Angeles • Milwaukee Minneapolis • New York • Kansas City, Mo. • Oakland • Philadelphia Portland, Ore. • Syracuse

Available in Old and Rerated NEMA Frames!

to be accurate to within ½ of 1% with flow turndowns of as much as 10:1. Chart planimetering is eliminated by direct six-digit readout. Instrument is reported to be insensitive to temperature changes between 30 and 130 F. Front panel space of about 3 x 3½ is required. A dc motor, with speed proportional to applied voltage, drives precision gear train and counter. **GPE Controls Inc, 240 E Ontario St, Chicago 11.**

Circle 326 on Reader Service Card

Dc-output pressure transducer

operable from 115-v ac line combines variable-reluctance pressure transducer and carrier-demodulator for dynamic and steady-state pressure measurement in single housing. Can be furnished with output of 0 to 5 v dc for voltage-controlled systems or 0 to 1 milliamp for galvanometer recording. Model accepts corrosive liquids and gases on both sides and is available in ranges 0.5 to 1000 psi, differential, gage or absolute. **Pace Engineering Co, 13035 Saticoy St, North Hollywood, Calif.**

Circle 327 on Reader Service Card

Multilead extension wire . . .

harnesses multiple pairs of thermocouple extension wires into special cables, cutting the cost of thermocouple wiring. Normally supplied with 4 to 48 pairs of extension wire per cable. All pairs of thermocouple wire are numbered and supplied in lengths up to 1000 ft from stock. In standard designs, multiple insulated wire-pairs are cabled with aluminum-backed mylar tape and choice of PVC over-all, steel armor over-all or combination steel arm and PVC over-all. **Pyrometer Co of America Inc, Pendel, Penna.**

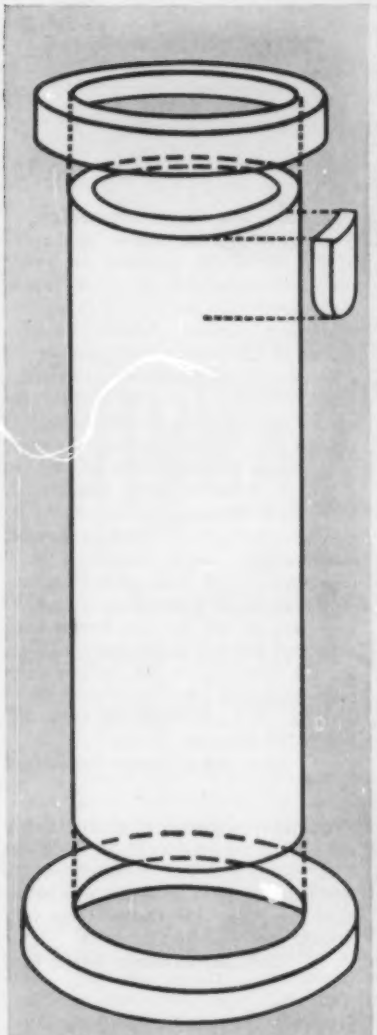
Circle 328 on Reader Service Card

Splined flexible shaft . . .

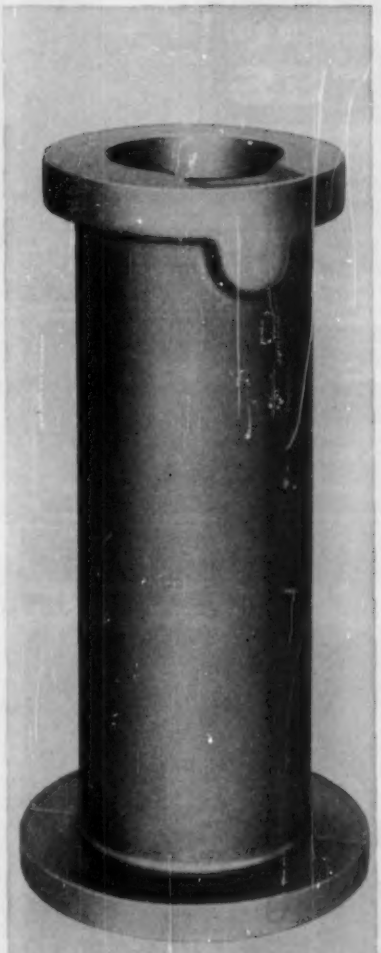
is for heavy-duty applications and transmits considerable rotary power over any curved path. Shaft has 1-in.-dia core, said to be capable of power transmission up to 760 in.-lb torque at 600 rpm. Layers of tightly wound high-grade music wire make up core. Heavy-duty flexible casing is lined with oil-tempered spring steel, which acts as bearing surface for core and is reinforced with wire braid. Casing is covered with oil-resistant, neoprene-impregnated fabric and abrasionproof rubber jacket. Equipped at one end with splined slip

continued on page 110

Unusual 1-piece design replaces 4-part assembly



Schematic showing parts assembly of barrel blank weldment.



Externally upset tube includes unusual boss, eliminates three parts. Barrel blank from SAE 1020 seamless tubing 3⅛" O.D. x ½" wall. Finished length 10.062". Finished weight 13 lbs. 2 oz.

COMMERCIAL exceeds the commonly accepted technique and specializes in unusual upset forging... combining advanced engineering with practical ingenuity. Here's how!

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coupling, which slides back and forth under load to take care of slight changes in length caused by varying load conditions. **Stow Mfg Co, 440 Shear St, Binghamton, NY.**

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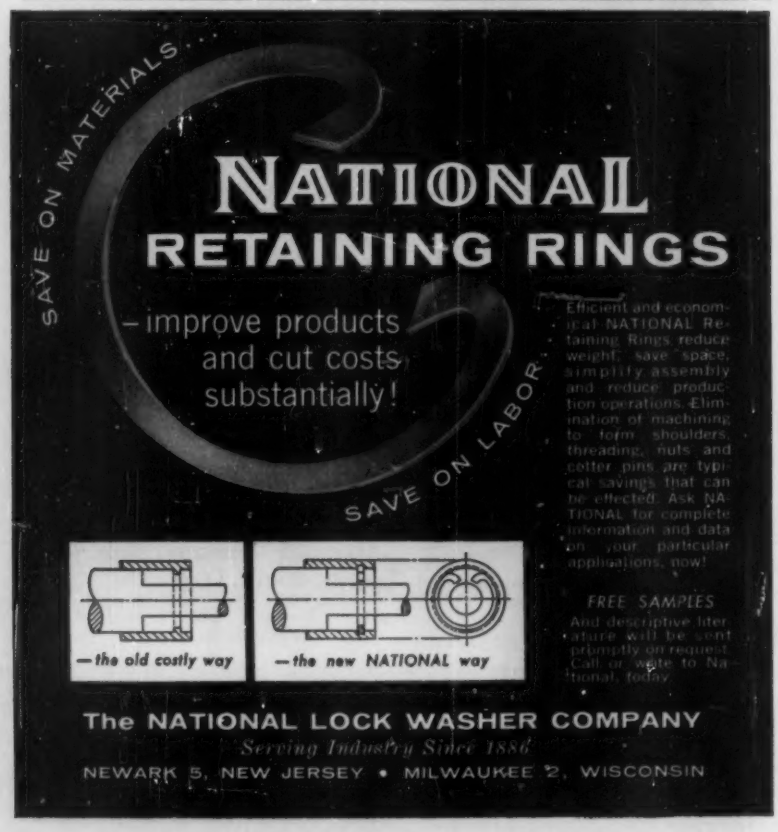
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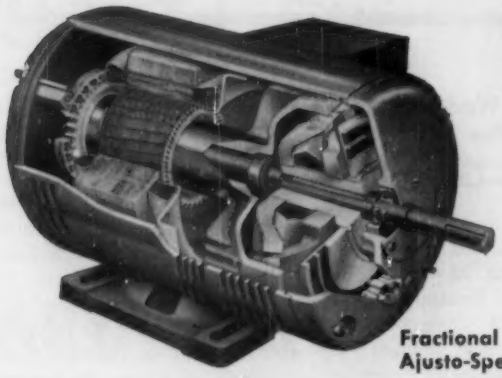

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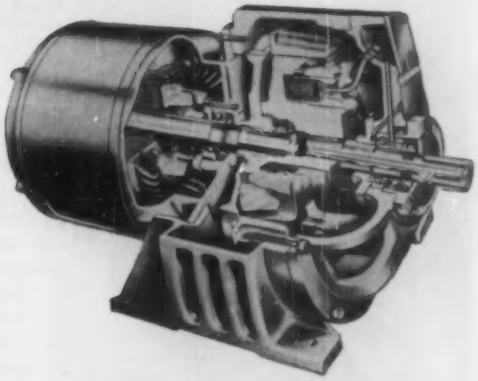

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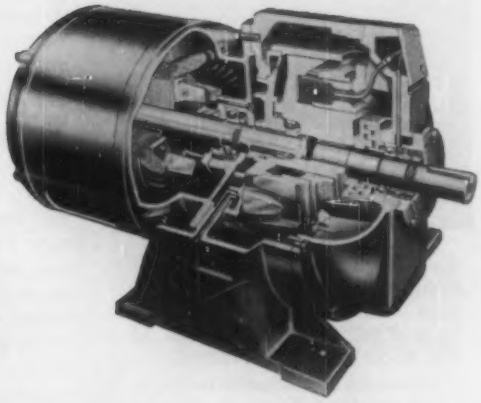

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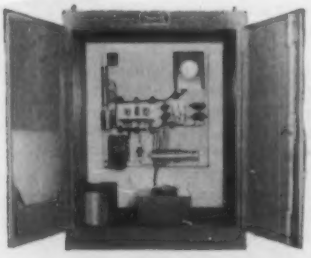

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DESIGN LITERATURE

The Dymaxion World of Buckminster Fuller

ROBERT W MARKS. Reinhold Publishing Corp, 430 Park Ave, New York 22. 232 pp, 8½ x 10½. $12.

This is a book about the life and work of a self-schooled inventor-designer-engineer, best known for his geodesic dome, the Dymaxion house and automobile, and "energetic-synergetic" geometry. Perhaps the best way to characterize Buckminster Fuller for engineers is to say that the clarity and simplicity of his grasp of the technology and science surrounding us today may well be the result of his self-study and self-analysis of engineering and mathematics—that is, if there is any validity in the opinions of certain educators and other authorities that the education of many engineers consists of teaching them what can't be done. To this reviewer at least, Fuller epitomizes much of what is imperative and indispensable in the engineering approach to the problems surrounding the tasks of satisfying the multiplying needs of mankind today. Unfortunately, Fuller also exhibits (both in this book and when interviewed—see page 24) the engineer's inability to cope with certain intangibles, including many of those inherent in creative design itself and the even more confusing examples to be found in present-day sociological and political phenomena.

This book can give its reader an excellent appreciation of the significance of Fuller's contributions, many of them as undervalued as they are unemployed, even today. Marks, the author, achieves an enthusiastic presentation based on a lengthy friendship with Fuller that is generally free of adulation and which even attains some objective appraisals.

Marks has provided a biographical sketch, presentations of Fuller's philosophy, the mathematical and engineering discoveries that led to the Dymaxion designs and cartography, energetic-synergetic geometry, and the geodesic theory of construction. There are also good pictures of much of the concrete results of Fuller's work.

All this should prove understandable even to the layman, although it is not overly popularized. The engineer should find it engrossing, along with some exhilarating discoveries about science and technology—and also his own relationship to them. He may even come to accept as a credo or goal for himself Fuller's description of Fuller: "I am not a creator. I am a swimmer and a dismisser of irrelevancies. Everything we need to work with is around us, although most of it is initially confusing. To find order in what we experience we must first inventory the total experiences, then temporarily set aside all irrelevancies. I do not invent my thoughts. I merely separate out some local patterns from a confusing whole." —JK

Two on Statistics

Chemical Statistics Handbook (5th Edition)

Manufacturing Chemists' Association, Inc, 1825 Connecticut Ave, N W, Washington 9, D C. 8¾ x 10¾, 521 pp. $3.

Economic Growth in the 1960's

National Industrial Conference Board, Inc, 460 Park Ave, New York 22. 7½ x 10, 33 pp. $1.50.

Two new statistical data books—one from the Manufacturing Chemists' Association and the other from the National Industrial Conference Board —give many interesting facts and figures. The chemical book is a 521-pp reference work that tabulates everything from plastic production to distribution of technically trained research workers.

The National Industrial Board's chart book is a more general and less statistical publication that presents, in attractive general form, current projective trends in research, production of major materials, jobs and population growth.

Complex Variables and Applications

RUEL V CHURCHILL, Professor of Mathematics, University of Michigan. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36. 9 x 6, 297 pp. $6.75.

This book, a second edition, presents differential and integral calculus of analytic functions, residues, and conformal transformations; and the connections between analytic and harmonic functions. The theory extends

continued on page 116

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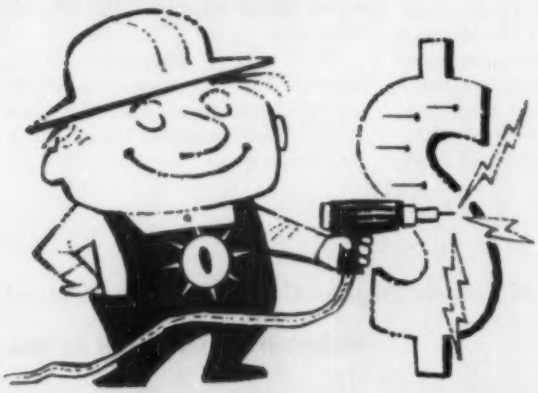

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Other Books of Interest

Planning by Design in a World of Product Change

American Society of Industrial Designers, 15 E 48 St, NY 17. 18 pp, 85¢.

Proceedings of 16th annual meeting of this society.

Zener Diode Handbook

International Rectifier Corp, El Segundo, Calif. 6 x 9, 100 pp, $2.

Investigation of the High-intensity-arc Technique for Materials Testing

Sheer, Fitz, Mead, Holmgren, Rothacker, Allmand. Office of Technical Services, US Dept of Commerce, Washington 25, DC. 8 x 10½, 99 pp, $2.50.

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"Planning an Extraprofessional Reading Program for Engineers," Charles E. Newman, General Motors Institute; General Motors Engineering Journal, April-May-June 1960, Technical Center, Warren, Mich.

Determining Material Cost

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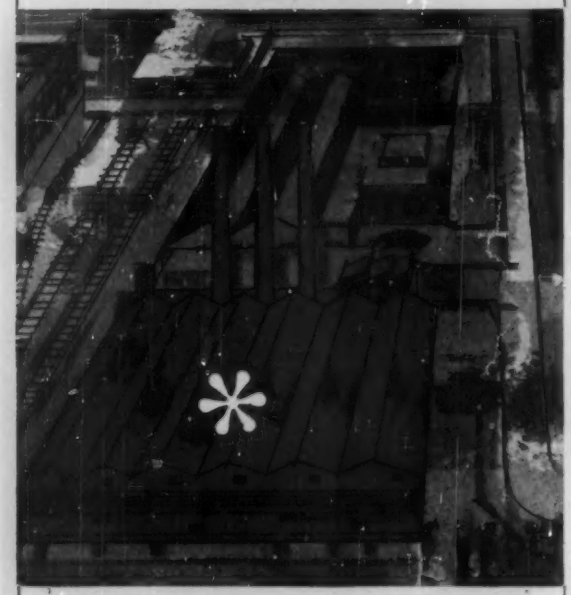

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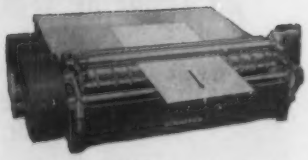

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tion requires that certain processing conditions can be estimated.

"How to Determine Material Cost," Modern Plastics, May 1960, 575 Madison Ave, New York 22.

Chemically Milled Parts

Describes the process briefly, and in more detail outlines primary applications, design information and standard practices.

"Design Consideration of Chemically Milled Parts," by Roy L. Chandler, Anadite Inc. Society of Aeronautical Weight Engineers Inc, c/o Douglas Aircraft Co, El Segundo, Calif.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 133.

AXIAL PISTON PUMPS—Bulletin 203, 8 pp. Presents information on use of axial piston pumps at up to 5000 psi. Illustrates performance and torque curves. Includes schematics that illustrate axial piston techniques of pumping, ratings chart for pumps and fluid motors. Denison Engineering Div, American Brake Shoe Co, 1160 Dublin Rd, Columbus, Ohio.

Circle 340 on Reader Service Card

SCREWS AND BOLTS—Brochure, 6 pp. Dimensional information, photos and drawings on hex and hex screws, carriage bolts and lag screws. Standard Screw Co, 2701 Washington Blvd, Bellwood, Ill.

Circle 341 on Reader Service Card

HEAVY-DUTY ELECTRIC IMPULSE COUNTERS—Bulletin, 6 pp. Includes operating instructions, circuit diagrams, electrical information for ac and dc models and dimensional information for various counters. Landis & Gyr Inc, 45 W 45th St, New York 36.

Circle 342 on Reader Service Card

SELF-LOCKING SCREWS AND BOLTS—Booklet, 8 pp. Explains operation, features and applications of one-piece self-locking screws and bolts. Continental Screw Co, New Bedford, Mass.

Circle 343 on Reader Service Card

HEAVY-DUTY GASKETING—Booklet R-260, 4 pp. Describes and illustrates a heavy-duty gasketing material and includes a sample. Spaulding Fibre Co Inc, 310 Wheeler St, Tonawanda, NY.

Circle 344 on Reader Service Card

DIGITAL-DATA PLOTTING EQUIPMENT—Bulletin DP6001, 8 pp. Describes digital plotting instrument, its accessories

continued on page 122

Another H&S Speed Reducer

on a tough job...

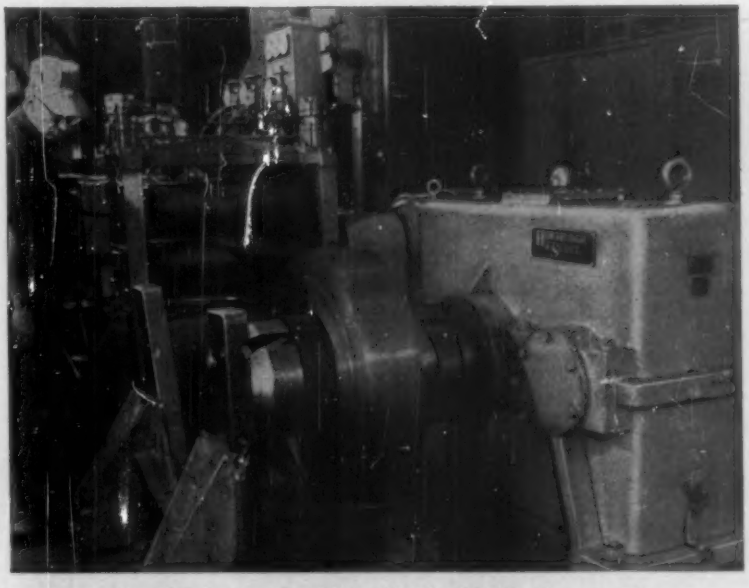
Built rugged for a critical rewind operation, this heavy overhung-load type H & S Herringbone Speed Reducer delivers day-in-day-out service under exacting load conditions.

This standard unit was selected for use on a Bliss precision rewind coiling machine—where strip steel must undergo tension controlled recoiling for subsequent annealing treatment.

Notice the sturdy shaft, with heavy-duty bearings designed to take this heavy overhung load. Observe the rugged housing, made to last.

This built-in toughness typifies H & S construction—on helical, herringbone, worm and combination units.

Send for detailed information on our facilities for producing a complete line of gears and speed reducers in a wide range of sizes and ratings.



Heavily loaded pay-off reel being driven by H & S Speed Reducer in plant of The Acme Steel Company, Chicago.

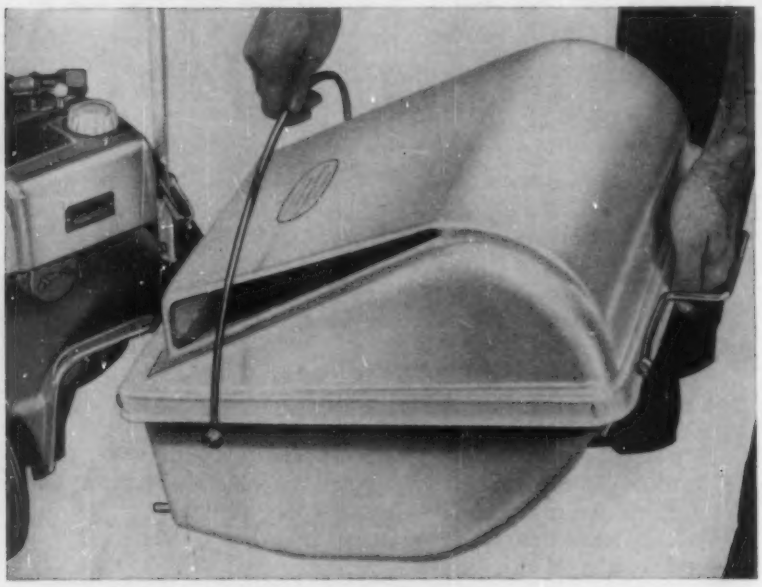
The HORSBURGH & SCOTT CO.

5112 Hamilton Avenue • Cleveland 14, Ohio

Specializing in fast production of quality Speed Reducers and Gearing to meet custom requirements.

CIRCLE 119 ON READER SERVICE CARD 119

CAMPCO
Plastic Sheet and Film / *some practical IDEAS for its use*



Campco Linear Polyethylene provides an added safety factor in this Jacobsen grass catcher

Here's something really unique in lawn mower accessories. Jacobsen Manufacturing Company of Racine, Wisconsin is offering something new, different and unquestionably better in this ingenious plastic grass catcher.

In designing the unit, Jacobsen engineers recognized the fact that solid objects such as stones, nails, glass, etc. ejected at high speed by the whirling rotary blades presented a definite hazard to the mower operator. Therefore, proper safeguards must be provided which would reduce this danger to a minimum. As to materials, canvas wore out too quickly. Metal dented too easily. Plastic seemed to offer the greatest possibilities. The question was, which material to use.

After consulting with Campco engineers, Jacobsen settled on Campco PE-200 Linear Polyethylene. This material combines light weight with extreme resistance to penetration by flying solids. Further, if penetration should occur, the small hole resulting will not tear.

Another safety factor designed into this catcher is an angle baffle which absorbs a great deal of the force of any flying object as the grass clippings are carried upward on the ramp. This formed-in-place baffle is made possible by the deep-drawing properties of Campco PE-200. The unit is vacuum-drawn in two sections; the base, which includes the formed-in-place baffle, and the cover. The cover forming is complicated by a cutout on each side, required to release air pressure built up by the mower blade.

The Jacobsen Grass Catcher is an integral part of their Turbo-Vac 18″ rotary mower. It measures 20″ long, 16″ wide and 12″ high.

Here's strength . . . plus good looks . . . with Campco Styrene

This new Pako Print Dryer has its dust cover, print tray and belt guard formed from Campco High Impact Styrene. This tough, rigid material is exceptionally strong and has remarkably good dimensional stability. Equally important is its low moisture absorption, as well as its good heat resistance, uniform thickness and excellent formability. For this application Pako selected the rich maroon color sheet which adds greatly to the appearance of the machine. The parts were vacuum-formed by Takor, Inc., of Delano, Minnesota.

Campco Styrene is ideal for this portable chemical mixer

This is the Pako 25-gallon Hydro-mixer which makes it possible to mix and transport photographic developing chemicals with one compact unit. Concentrated liquids, powders and crystals are mixed and ready for use in a matter of minutes. The tank is vacuum-formed of sturdy Campco high impact white styrene which provides not only ample strength but resistance to chemicals as well.

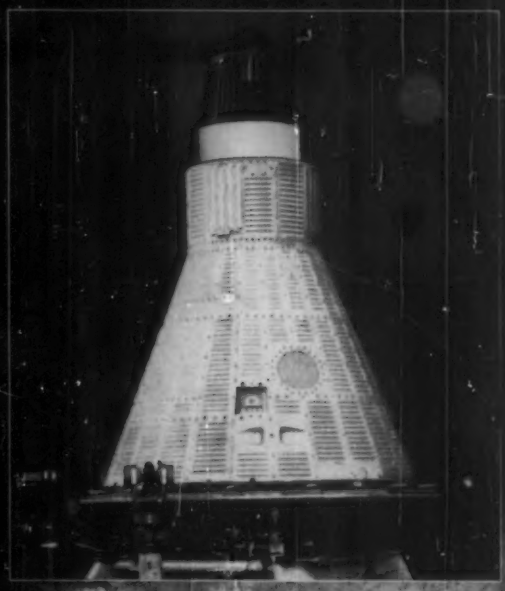
Received Your Campco Personal File? This data-packed reference file on thermo-plastic sheet and film is yours on request — just send name and address on your company letterhead to Campco, 2717-C Normandy Avenue, Chicago 35, Illinois.

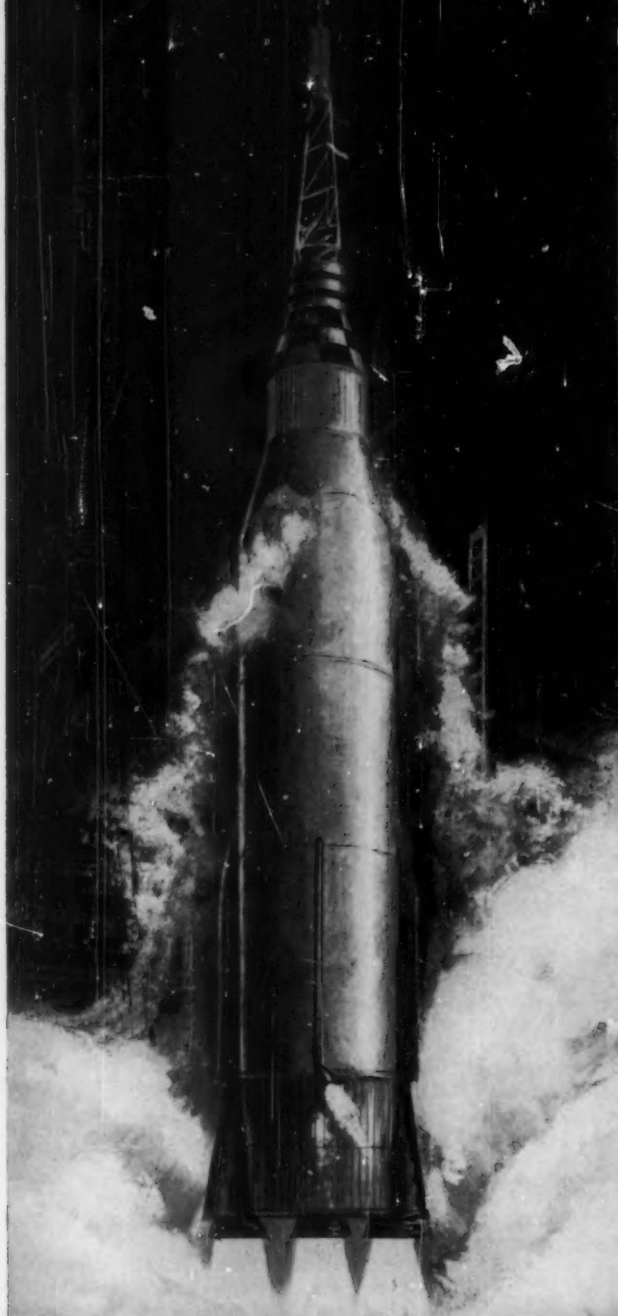
CAMPCO Sheet and Film, **a Division of Chicago Molded Products Corp.**

SIGNIFICANT ADVANCES IN BERYLLIUM TECHNOLOGY COME FIRST FROM BRUSH

FORGING INTO SPACE

Beryllium heat sinks are being readied for test flights.





Right now scientists and engineers from the National Aeronautics and Space Administration and McDonnell Aircraft are working toward the day when the first American will ride into space to orbit the earth.

How do beryllium and Brush fit into the Project Mercury manned space flight effort? A beryllium heat sink is one of two ways being tested to protect the precious human payload from re-entry heat. Beryllium absorbs tremendous heat, is light, yet maintains strength at high temperature. And Brush developed new techniques to produce the world's largest beryllium forgings for use as heat sinks in the tests to determine the final design of the manned space capsule.

Beryllium offers the solution to many 'space age' application problems. Brush will continue to take the lead in producing beryllium in new forms by new techniques for new uses.

Can this metal, its alloys, its oxide, or our expanding experience with these versatile materials solve a problem for you? Let us try. Contact us at 5209 Euclid Avenue or ENdicott 1-5460 in Cleveland, Ohio.

THE BRUSH BERYLLIUM COMPANY

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You can depend on

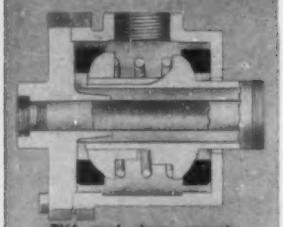
PY4

Morganite

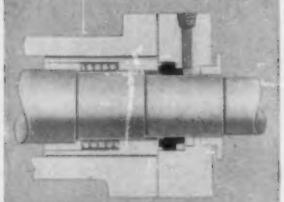
SEALS

Application tested for all sealing requirements

Service-proven on toughest assignments



PY4 seal rings operate with highest efficiency in this rotary pressure joint carrying steam-condensate.



Mechanical seals with Morganite PY4 noses provide an extra measure of dependability in this stuffing box assembly.

LINK PY4 GRADE of self-lubricating MORGANITE is the engineer-preferred seal material for every application where premium performance is a "must." Actual service records compiled on PY4 Seals in all types of rigorous service, prove that this super-rugged material can take punishment! PY4 Seals function with highest efficiency in the presence of grease, searching liquids, corrosives, high pressures and high temperature. Install Morganite LINK PY4 for longer seal life . . . reduce down-time and save on seal replacement costs.

AVAILABLE WORLDWIDE — Send drawings and operating data for a recommendation on your specific seal requirements.

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and capacity, used for reducing data to charts, graphs, drawing. Electronic Associates Inc, Long Branch, NJ.

Circle 345 on Reader Service Card

CHASSIS SLIDES—Brochure, 4 pp. Non-scale, dimensional drawings of several chassis slides available. Grand Sliding Mechanisms Inc, 2401 W Ohio St, Chicago 12.

Circle 346 on Reader Service Card

EXTRUDED RECTANGLES—Bulletin G-50a, 4 pp. Contains sizes, weights, typical physical properties and specifications of extruded aluminum bronze rectangles for wear and abrasion applications. Ampco Metal Inc, Box 2004 Milwaukee 1.

Circle 347 on Reader Service Card

INFRARED DETECTORS—Brochure, 4 pp. Characteristics of various products that find application as infrared sensors. Eastman Kodak Co, 343 State St, Rochester 4, NY.

Circle 348 on Reader Service Card

SHOCK AND VIBRATION ISOLATOR—Catalog sheet, 2 pp. Construction, performance characteristics and load ratings of Series 1000 isolators. Barry Controls Inc, 700 Pleasant St, Watertown 72, Mass.

Circle 349 on Reader Service Card

PUSHBUTTON SWITCH—Bulletin 5500, 1 pp. Describes momentary-action type switch, available with single or double spring pile-ups mounted on both sides of frame. Donald P Mossman Inc, Brewster, NY.

Circle 350 on Reader Service Card

REFRACTORY METAL CHART—Shows properties of tungsten, tantalum, molybdenum and columbium. Reverse side contains temperature-conversion chart for Fahrenheit and Centigrade. Fansteel Metallurgical Corp, Dept PE-1, Metals and Fabrication Div, North Chicago, Ill.

Circle 351 on Reader Service Card

IMPACT EXTRUSIONS—Brochure FM-3019, 12 pp. Discusses process and how impact extruded parts can be applied. Mueller Brass Co, Port Huron, Mich.

Circle 352 on Reader Service Card

STRAIN-RELIEF GRIPS—Catalog 60, 24 pp. Describes and illustrates various grips for industrial use. Gives dimensional and application information. With price list. Kellems Co Inc, Stonington, Conn.

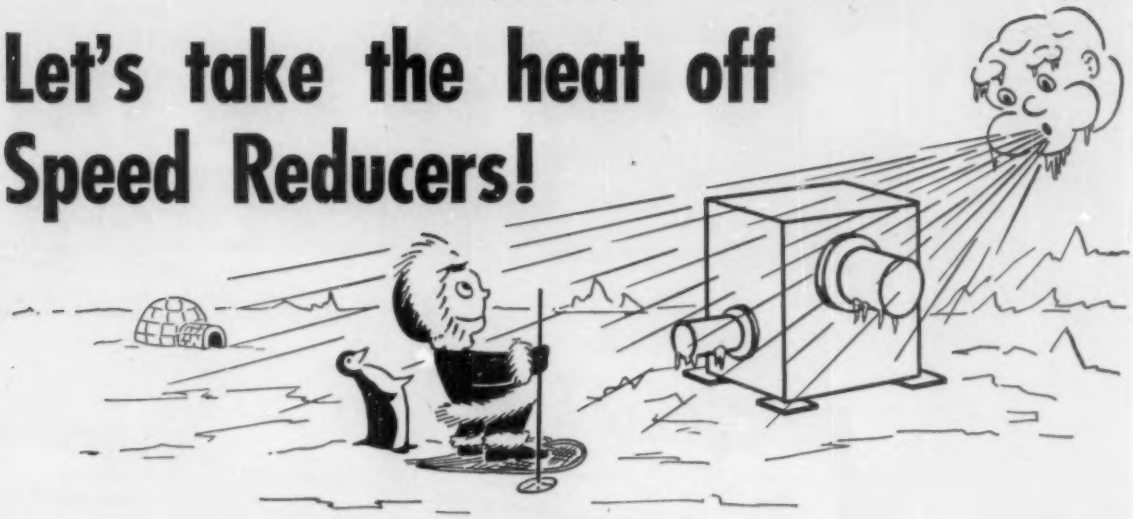
Circle 353 on Reader Service Card

PREPARING FOR PATENT-HOOD—Brochure, 20 pp. Revised booklet tells what to do with invention idea; when to talk with a patent attorney; importance

continued on page 126

(*Advertisement*)

Let's take the heat off Speed Reducers!



A worm gear speed reducer is one of the toughest little customers in captivity. It reduces speeds day-in, day-out, with little complaint. While it works long and hard, it has limitations—set by ratio, center distance, RPM, mechanical and thermal HP ratings, etc. And, depending upon how precisely it was selected and fitted to the job requirements, it will do what it has to do.

But sometimes it's forced to play outside of its league. It must cope with job requirements that vary from here to there—normal 8 to 10 hour service without recurrent shock, the same length of service where there is some shock loading, continuous low-speed service and almost countless others. But the thing that really puts the pressure on reducers, the thing that's lurking in *every* set of job requirements—is h-e-a-t.

When you exceed the thermal capacity of a reducer for more than an hour or so, excessive temperature thins the lubricant resulting in wear; material, bearing and oil seal failures; etc. Of course, the proper lubricant will help but it can't cure the continuing problem of excessive heat.

So how can we lick this toughy? One way is to build the reducer housing oversize, big enough to radiate the heat away and keep temperatures down. But this type sticks out in aisles, louses up compact designs and barks shins. Then, we might try a smaller housing complete with fins on it to dissipate the heat. If this still doesn't work, another trick is to use a reducer with capacities and ratings a step above the ones we need. This is sending a man to do a boy's job. It's impractical, inefficient and costly. There *has* to be an easier, better, saner and cheaper way to do it. And there is!

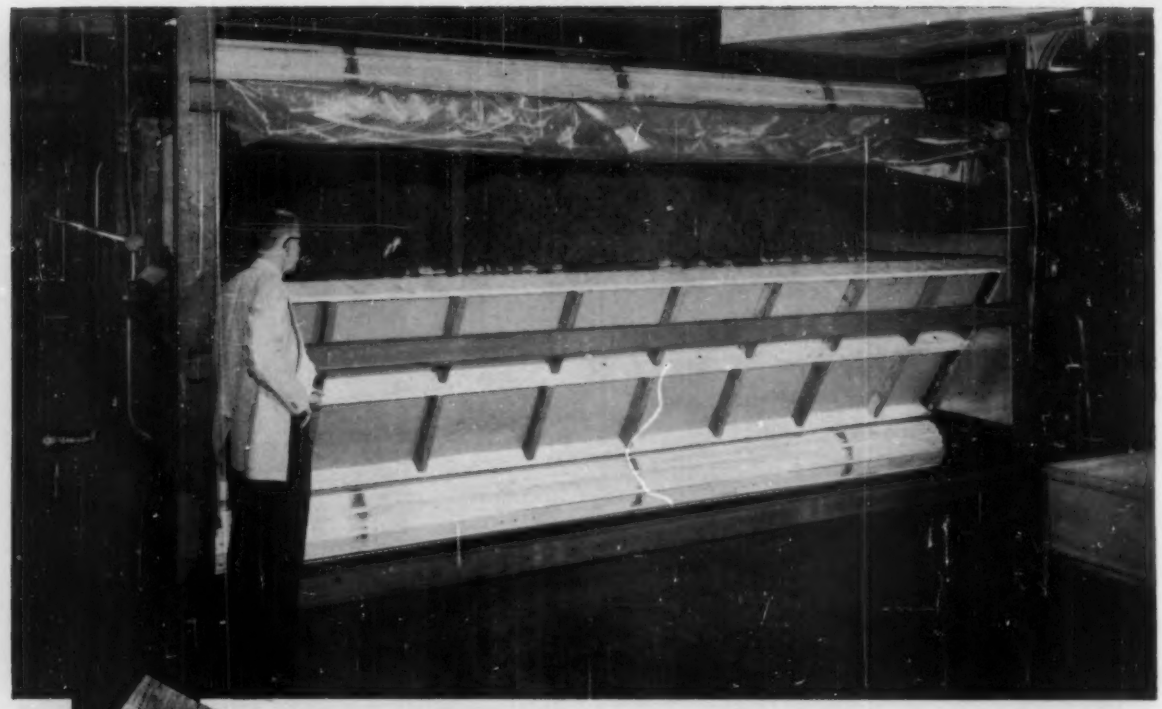
In certain cases, where the size and type of reducer permits and where we can gain enough in thermal HP rating to keep heat generation in bounds, Cone-Drive Gears does it with fan-cooling.

What's that? Simple. Just add a fan to the worm shaft plus the necessary air shields, fan cover, etc., and presto!—heat is no longer a problem. The air shields direct the fan-pushed air over the fins on the lower portion of the reducer. The fins are shaped and spotted to guide the air stream where it is needed. Thermal HP ratings are boosted tremendously, as high as 147% above those of standard reducers in some cases! Those over-worked, over-heated reducers will now do the job you bought them to do.

Other advantages? They're here in abundance. The size of the reducer stays the same. All parts on a Cone-Drive fan-cooled reducer are 100% interchangeable with parts for standard reducers. Oil capacity is identical. Shields are quickly removed without disconnecting the reducer. (This is important where severe operating conditions make periodic cleaning necessary). The reducer can also be operated *without* fan-cooling just by taking off the fan and shields.

This simple addition to standard Cone-Drive HU speed reducers might be just your answer—might save you some money. Write for Cone-Drive's Bulletin CD-218. It will tell you all about the full line of Cone-Drive double-enveloping worm gear reducers as well as the fan-cooled kind. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

CIRCLE 123 ON READER SERVICE CARD 123



from factory floors...to tobacco conveyors...

GAMBLE solves problems with WOOD!

PROBLEM: Ordinary industrial wood block flooring was breaking up rapidly at heavy-traffic spots like loading docks, intersections, and aisles.

SOLUTION: Wood engineers at Gamble Brothers developed a laminated end-grain hickory block which lasts up to 10 times longer, despite punishing loads that quickly break up ordinary flooring.

PROBLEM: Tobacco conveyors required long orifice-forming slats whose dimensions would not change, even after use in a moisture-control operation in cigarette-making.

SOLUTION: Gamble Brothers designed a laminated slat of maximum dimensional stability, bonded by water-proof, heat-proof, non-taste-imparting adhesives. Our facilities enabled us to build the slats under environmental conditions identical to those to be experienced at end use.

Design problems like these are "all in a day's work" to the wood engineers at Gamble Brothers — a unique organization designing and building a wider variety of wood products than any other U. S. woodworking company. Today they're working in three principal areas: (1) improvement of present wood products (2) development of new wood products (3) product development in combinations of wood and other materials.

Why not present *your* design or component problem to Gamble Brothers? WOOD may be the answer!

FREE booklet illustrates GAMBLE services

This 28-page booklet describes Gamble facilities and services in detail. Includes many photographs of unusual products designed, tested and perfected by Gamble Brothers. Write for your copy today! Gamble Brothers, Inc., 4617 Allmond Ave., Louisville, Ky.

If the problem involves wood, Gamble can help!

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. . . . . What's the limit: Heat? Shock? Speed? Or complicated radial and thrust loads?

Name the combination of requirements . . . and chances are you'll find them met by a Rollway Maximum precision radial cylindrical roller bearing. If not, then Rollway engineers will modify any factor to meet your application.

Rollers are crowned to prevent end-loading and the resultant spalling of races. Directional trueness is maintained by retainers of standard bronze or "Rollube" ferrous alloy of one piece or two piece construction.

You may wish to refer to the Rollway Catalog and Engineering Data Book when writing specifications for a high precision bearing. It contains the first listing, by any manufacturer, of the thrust capacities of cylindrical radial roller bearings. Send for it today.

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AT BOTH HIGH AND
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A mount soft enough to isolate vibration in the upper range of frequencies generally gives trouble with a low natural frequency. With sensitive precision equipment, such as airborne sighting mechanisms, for example, a mount must work at *both* ends of the frequency spectrum.

ANSWER:
MB ISO-DAMP (tm) MOUNTS
CONTROL FULL
FREQUENCY RANGE

Resilient rubber sections with equal spring rates in all directions (an original MB mount principle) give the MB Isomode Mount its high frequency isolation efficiency in any position. In the low range, a unique damping mechanism effectively restricts resonant build-up; does not affect high frequency isolation. Unit also meets MIL-E-5272-A shock requirements.

WHAT'S YOUR
MOUNT PROBLEM?

Iso-Damp mounts can be modified to meet your particular requirements. Or possibly one of MB's other standard mounts may be the answer to your special vibration control problem. Why not let MB's experienced specialists help find the right answer for you. Write us for complete information—ask for Bulletin 418-4.

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of dates and a verifier; about the patent office; application handling; revising claims; claims and patents; economic importance of patents; and foreign patents. Trak Electronics Co, Div of CGS Laboratories Inc, 49 Danbury Rd, Wilton, Conn.

Circle 354 on Reader Service Card

ONE-PIECE BLIND RIVET—Catalog, 16 pp. Covers operation, construction and application of one-piece rivet with internal threads. Cutaway views, diagrams and photos supplement text. B F Goodrich Aviation Products, Div of B F Goodrich Co, 500 S Main St, Akron 18, Ohio.

Circle 355 on Reader Service Card

COMPRESSED-SHEET MICA PRODUCTS—Catalog 26, 24 pp. Specifications of mica hard plates; flexibles and flexible combinations, micapaper rolls, sheets and tapes; as well as fabricated parts made to customer specifications. Includes NEMA requirements for manufactured mica sheets and wrappers. Insulation Manufacturers Corp, 565 W Washington Blvd, Chicago 6.

Circle 356 on Reader Service Card

HYDRAULIC AND AIR CYLINDERS—Bulletin Pr-300-R, 12 pp. Contains price information on air and hydraulic cylinders, boosters, accessories and optional cylinder components. Lower base prices on small to medium-bore hydraulic cylinders and other price adjustments are incorporated. Miller Fluid Power Div, Flick-Reedy Corp, York and Thorndale Rds, Bensenville, Ill.

Circle 357 on Reader Service Card

SQUARE-HEAD AIR AND HYDRAULIC CLINDERS—Bulletin SQ-3-60, 16 pp. Covers increased range of cylinders. Gives specifications on bore sizes, rod dimensions, allowable strokes and other information. Tomkins-Johnson Co, 2425 W Michigan Ave, Jackson, Mich.

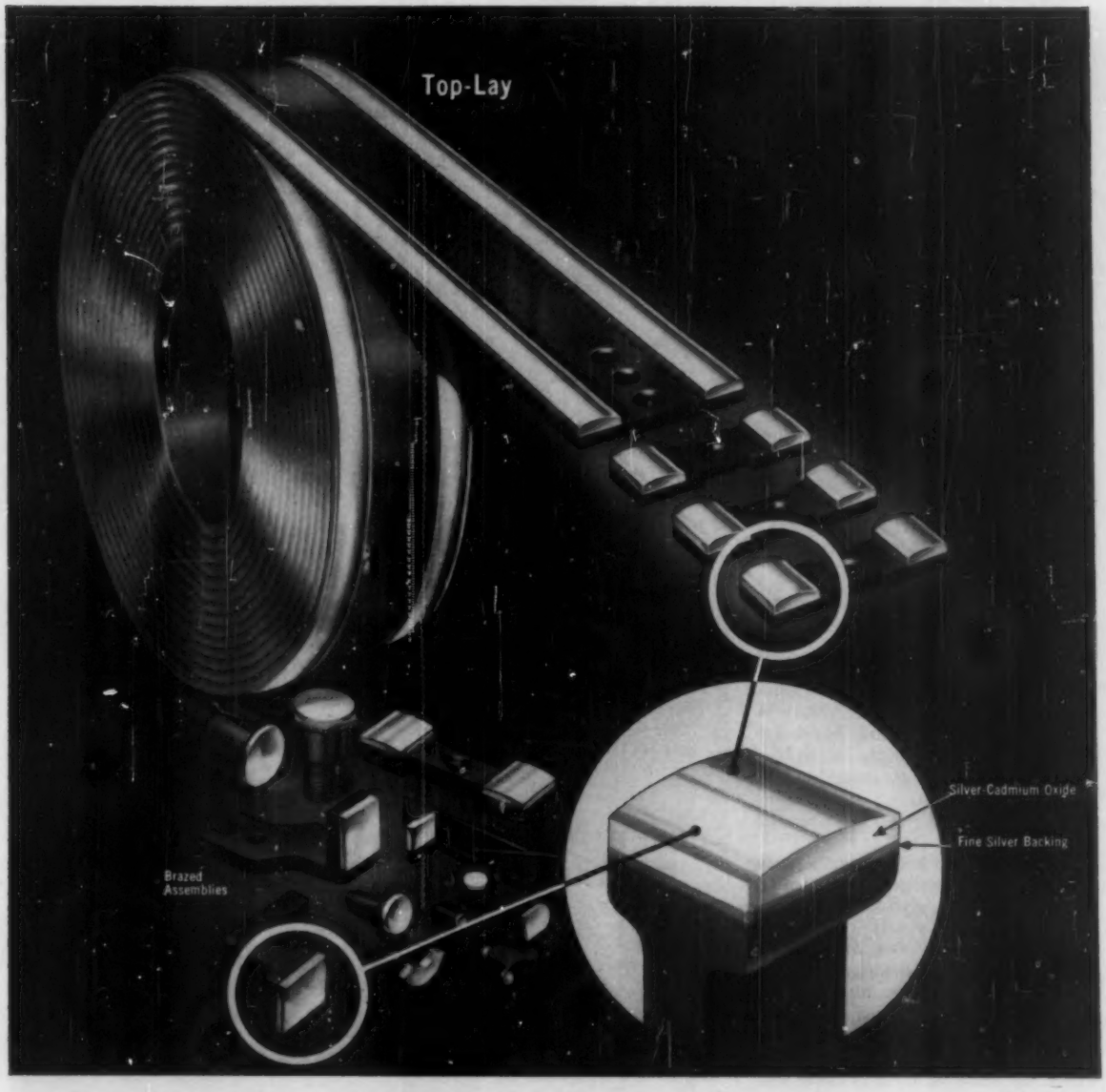
Circle 358 on Reader Service Card

SYNCHROS AND RESOLVERS—Manual, 28 pp. Illustrated technical discussion of electrical characteristics of synchros and resolvers. Describes application and significance of such parameters as electrical error, electrical zero, fundamental null, total null, transformation ratio, and phase shift. Methods of measurement and basic specifications for test equipment are also included. Theta Instrument Corp, 520 Victor St, Saddle Brook, NJ.

Circle 359 on Reader Service Card

MOTORIZED PULLEYS—Catalog 659, 12 pp. Specifications and dimensions for models of standard pulleys from 1 to 75 hp and with face widths of 22 to 57 in. Includes installation diagrams and descrip-

continued on page 131



General Plate Silver-Cadmium Oxide Top-Lay and Brazed Assemblies

Increase Product Performance at Substantial Cost Savings

General Plate Silver-Cadmium Oxide Contacts provide users with many worthwhile advantages. Resistance to welding and arc-erosion, the benefits normally gained with Silver-Cadmium Oxide, are coupled with an ease of fabrication not normally associated with this material. The difference is a heavy fine silver backing that assures a superior bond to the supporting member.

General Plate can supply Silver-Cadmium Oxide in Top-Lay material from which complete contact assemblies are produced by simple "blank and form" operations. This reduces manufacturing costs substantially, yet assures a better engineered product.

For contact assemblies not readily produced from Top-Lay, Metals and Controls specializes in supplying complete fabricated brazed contact assemblies ready for installation. This can save you money, time, and trouble.

Silver-Cadmium Oxide Contacts are also available as rivets, buttons for welding, and welding tape.

It will pay you to investigate General Plate Silver-Cadmium Oxide Contacts. Our competent Field Engineers will gladly call at your request and review your contact problems. Write today.

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CIRCLE 127 ON READER SERVICE CARD 127

(Advertisement)

NO. 6 OF A SERIES

"How to Design Welded Aluminum Structures"

Choice of Proper Filler Alloy Can Increase Strength of Welded Aluminum 40%

Mr. Harry N. Hill, *Engineering Design Division Chief, Alcoa Research Laboratories, Aluminum Company of America, reports research findings presented at the 1959 annual meeting of the American Society of Civil Engineers.*

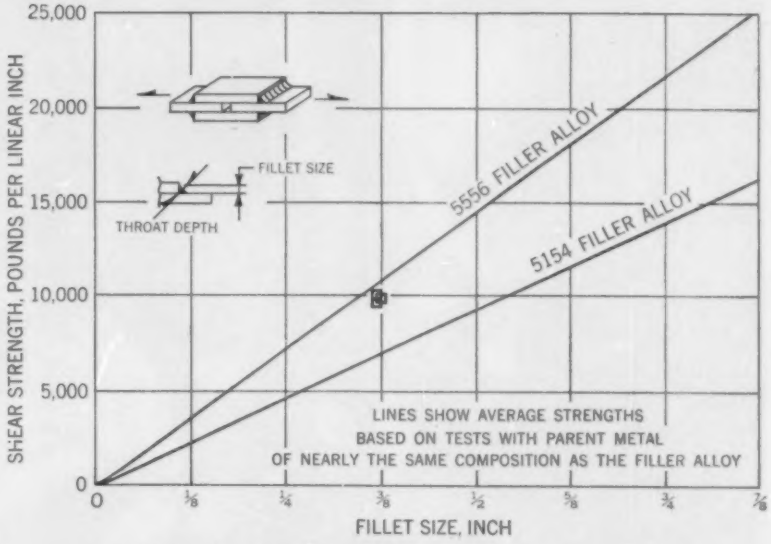
Use of a filler alloy nominally the same composition as the parent metal is common practice in joining aluminum alloys. Investigation at the Alcoa Research Laboratories, however, reveals that this widely accepted technique rather seriously penalizes the strength of welded joints!

Strength is most frequently the controlling factor in selecting a particular filler alloy. For *maximum* strength, apply the following general rule: *Where possible, use a filler alloy that will be stronger in the weld than the parent metal adjacent to the weld.* An investigation of fillet-weld strength reveals why.

A fillet weld transmits load by shear . . . particularly longitudinal fillet welds, where the shearing force is along the length of the weld.

Minimum shear area occurs at the throat depth. Since shear area at the sides of the fillet is about 40 per cent greater than at the throat area, a longitudinal fillet weld will fail in shear at the throat section unless the weld is stronger than the adjacent metal by about 40 per cent or more. Use of a higher strength filler alloy can therefore increase the strength of a longitudinal fillet weld by about 40 per cent.

In a transverse fillet weld, the complex stress state makes a simple analysis impossible. The accompanying chart demonstrates the increased strength actually realized with the use of higher strength filler alloy in transverse fillet welds. Fillet welds in alloy 5154 were *35 per cent stronger* when made with filler alloy 5556 than when made with filler alloy of the same composition as that of the parent metal.



SHEAR STRENGTH OF TRANSVERSE FILLET WELDS OF 5154 PLATE—USING 5556 FILLER

The increased strength of fillet welds thus obtained permits use of less weld for a given load with consequent savings in both material and welding costs.

Although the advantages of higher strength filler alloy are greatest in fillet welds, tests indicate some improvement with welded *butt joints.*

In selecting the best combination of parent and filler alloys, the designer must consider such matters as ease of welding, corrosion resistance, operating temperature, ductility, and sometimes color . . . in addition to strength. Alcoa has prepared a handy filler metal selection chart to help you, which is available free on request.

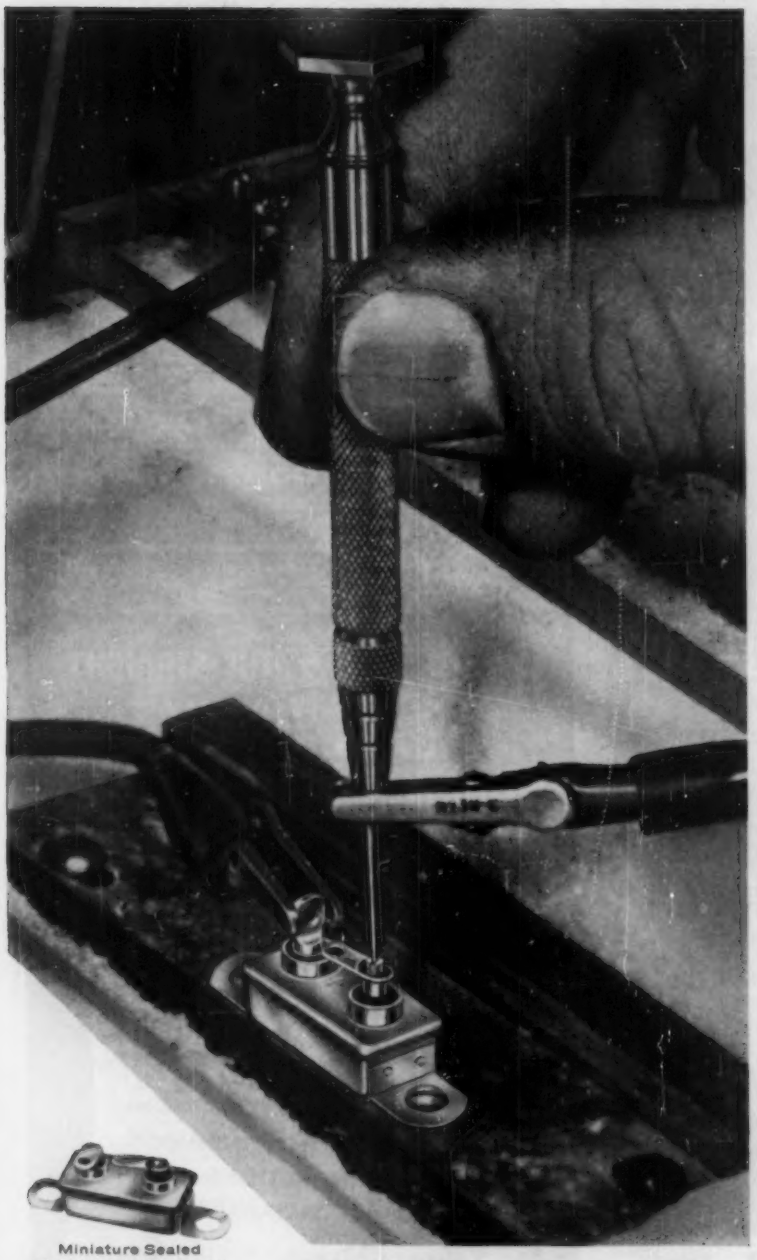
The next article in this series will present basic design data for the most important of the weldable aluminum alloys. A final article dealing with the fatigue strength of welded aluminum alloys will conclude the series.

For top-quality aluminum welding products such as consumable electrodes, welding and brazing rods and fluxes, and solder and soldering fluxes, contact your nearest Alcoa sales office. For more complete information on "Designing Welded Aluminum Structures," write Aluminum Company of America, 1760-F Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM

WELDING MATERIALS

Tested To "Take It" on Missiles or Machines...



Miniature Sealed
THERMOSWITCH Unit
(actual size)

The Fenwal Miniature Sealed THERMOSWITCH® Unit

Here's the tiny temperature controller that's successfully handling some of today's toughest temperature control problems . . . in missiles and rockets as well as on production machines. Photo shows one of many quality control tests to insure product performance. *It's built to take a beating!*

Hermetically sealed, its rugged design permits normal control action even under the most severe conditions of shock and vibration. Stainless steel case is the heat-sensitive element . . . responds with instantaneous, positive action to heat changes of a fraction of a degree. Unit controls to extremely close limits. *Weighs less than ⅓ oz.!*

Easily set for *control* of temperatures from −20 to +200°F. When used as *high limit* switch, range is −20 to +275°F. Can withstand continuous exposure from −65 to +325°F. The Fenwal Miniature Sealed THERMOSWITCH Unit is widely used for crystal ovens, tuning forks, gyro assemblies, missile blankets, and missile batteries. Current rating: 2.5 amps, 115 VAC, 2.0 amps, 28 VDC. Find out how this advanced controller can protect the reliability of your product. Write Fenwal Incorporated, 26 Pleasant Street, Ashland, Mass.

Another example of how **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

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Locking feature in the center for fast feeding. Can be applied from either end.
GRIPCO CLINCH NUT
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With or without Gripco Lock. Centering collar positions nut and protects threads from weld spatter.
GRIPCO COUNTERSUNK-WELD NUT
With or without Gripco Lock. Countersink protects threads from weld spatter.

All types and sizes of Gripco fasteners listed in catalogue are available for immediate delivery.

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- STAINLESS STEEL LOCK, WELD AND SEMI-FINISH NUTS.
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124

130 CIRCLE 130 ON READER SERVICE CARD

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Guarantee positive tight connections and extra long service on your pipe lines by using the DART GUARANTEED UNION.

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CIRCLE 206 ON READER SERVICE CARD

tions of available accessories and modifications. Four charts help in determination of proper pulley. Western Conveyor Co, PO Box 357, Boise, Idaho.

Circle 360 on Reader Service Card

METAL-POWDER CORES—Bulletin G1, 12 pp. Presents information on electronic core loss and Q calculation data, inductance variation with temperature and induction variation with dc current. Covers core dimensions and tolerances, types of finishes, electrical specifications, standard core sizes and types of core specifications. Magnetic Metals Co, Hayes Ave at 21st St, Camden, NJ.

Circle 361 on Reader Service Card

INSTRUMENTS AND EQUIPMENT—Catalog 60, 16 pp. Contains illustrations and brief descriptions of 77 testers manufactured as standard products. Custom Scientific Instruments Inc, Kearny, NJ.

Circle 362 on Reader Service Card

AUTOMATION—Bulletin GED-3908, 16 pp. Management-oriented publication discusses technology, equipment and economics of automation. GE products, facilities and engineering capabilities are discussed as they apply to automation of industrial and commercial processes. General Electric Co, Schenectady 5.

Circle 363 on Reader Service Card

MAGNETIC LAMINATIONS—Catalog TB-106, 36 pp. Information, formulas and specifications of shapes available. Catalog also introduces new parts-numbering system. Cross reference index guide on back cover shows additional comparison figures and specifications for individual shapes. G-L Electronics, Camden 5, NJ.

Circle 364 on Reader Service Card

SHADED-POLE FAN MOTORS—Bulletin GEC-219F, 4 pp. Discusses applications and features of totally enclosed fan motor. Outlines testing procedures and construction and includes motor ratings, sizes and fan-blade information, as well as motor dimensions and operating information. General Electric Co, Schenectady 5.

Circle 365 on Reader Service Card

TOOL STEELS—Comparison guide, 28 pp. Index reference lists tool steels by trade name, classification and number. Presented according to AISI-SAE classifications. Peninsular Steel Co, 24401 Groesbeck Highway, Detroit 5.

Circle 366 on Reader Service Card

MACHINING OF TEFLON—Booklet 0701, 8 pp. Contains suggestions for stress relieving, tools and coolants to use;

continued on page 138

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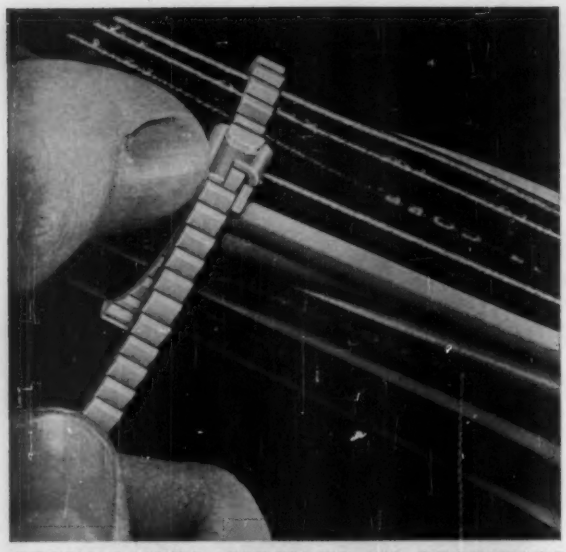

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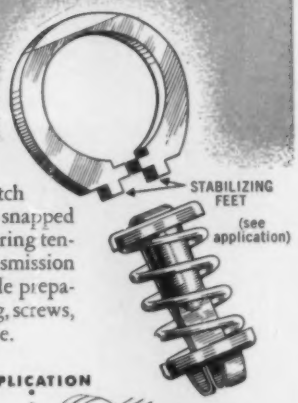
CIRCLE 209 ON READER SERVICE CARD

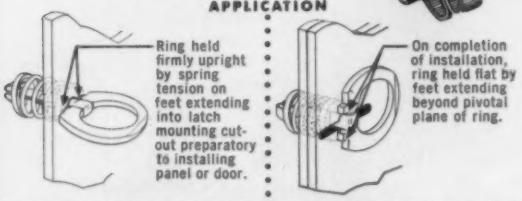
SPRING LOADED LATCH for removable panels and access doors



Completely assembled, installed in 5 seconds. Latch slips through hole, ring is snapped on. ¼ turn to operate. Spring tension eliminates noise transmission and vibration. Simple hole preparation. Eliminates riveting, screws, spot welding. Inexpensive.

Write for circular.

APPLICATION


Ring held firmly upright by spring tension on feet extending into latch mounting cut-out preparatory to installing panel or door.
On completion of installation, ring held flat by feet extending beyond pivotal plane of ring.

MAKERS OF DOT PRODUCTS

MONADNOCK MILLS
SAN LEANDRO, CALIFORNIA
SUBSIDIARY OF
UNITED-CARR FASTENER CORP., BOSTON, MASS.

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copies of catalogs & bulletins

speeds and rates of feed; rakes; angles and clearances; burrs and chips; and other basics. Plastic Products Div, Raybestos-Manhattan Inc, Manheim, Penna.

Circle 367 on Reader Service Card

HIGH-DENSITY DELAY LINES—Brochure, 18 pp. Describes advantages and limitations of all different types of delay lines available. Explains factors to consider when establishing specifications and their effect on cost of line. Gives specifications and ratings of standard, fixed and variable delay lines. Valor Instruments Inc, 13214 Crenshaw Blvd, Gardena, Calif.

Circle 368 on Reader Service Card

LIQUID-LEVEL GAGES, VALVES—Catalog 376, 8 pp. Covers line of liquid-level gages and valves, with condensed presentation of construction, ratings, sizes and specifications. Includes dimensional drawings and photos. Jerguson Gage & Valve Co, 80 Adams St, Burlington, Mass.

Circle 369 on Reader Service Card

TEST AND SENSING COMPONENTS—Guide and wall chart. Contains specifications on panel lights, switches, fuseholders, test prods, jacks and molding materials. Alden Products Co, Dept TS 89, 117 N Main St, Brockton 64, Mass.

Circle 370 on Reader Service Card

SPRING MATERIALS—Digest, 8 pp. Discusses various spring properties of several groups of metal alloys. Contains several comparison tables and charts in addition to general discussion of each alloy. Riverside-Alloy Metal Div, H K Porter Co Inc, Riverside, NJ.

Circle 371 on Reader Service Card

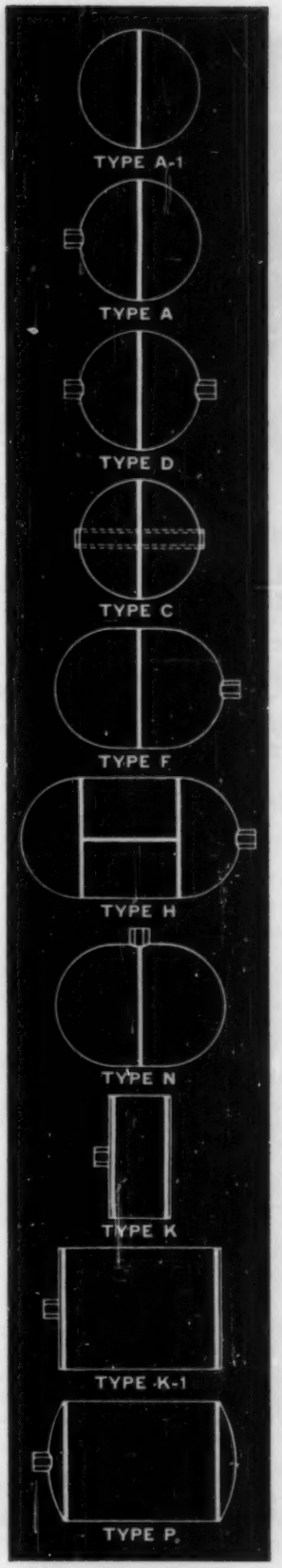
SOLDER-JOINT VALVE—Folder, 4 pp. Lists size and dimensions of gate, globe and check solder-joint valves. Each type is illustrated with cutaway view that shows flow path of fluids through valve body. Walworth Co, 750 3rd Ave, New York 17.

Circle 372 on Reader Service Card

LETTERHEAD REQUESTS ONLY

Manufacturers who published following literature asked that requests for copies be made on company letterheads.

PILOT LIGHTS AND LAMPS—Manual, 256 pp. Provides information on pilot lights and the lamps for which they are made. Discusses 15 types of incandescent and six types of neon glow lamps. Text covers specific assemblies designed to receive lamps, including life-size illustrations. Includes dimensions, lens styles, finishes, optional features, mounting clearance hole and other specifications. Separate 8-pp catalog number index is provided as a numerical cross-reference for use with handbook. Dialight Corp, 60 Stewart Ave, Brooklyn 37, NY.



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all shapes and sizes for high pressure service

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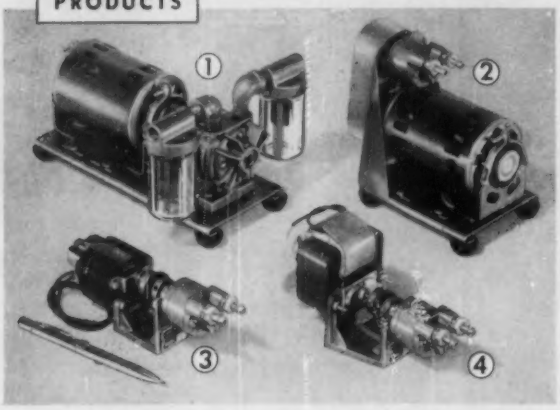
CIRCLE 133 ON READER SERVICE CARD 133

ROTARY AIR
GAST
PRODUCTS

NEW for 1960



TWO TYPES OF MINIATURE OIL-LESS

GAST Rotary Vane VACUUM PUMPS and AIR COMPRESSORS

① Model 1030-V110-206 Vac. Pump, 1/20 h.p. Up to 1 c.f.m ; to 15" vac.

② Model 0330-V112-206 split phase 1/20 h.p. motor, .48 c.f.m. Up to 20" vac. or 15 p.s.i.g.

③ Model 0330-V102A-151 series wound motor. Up to .67 c.f.m. To 20" vac. or 10 p.s.i.g.

④ Model 0330-V110-202 shaded pole motor. Up to .35 c.f.m. To 20" vac. or 10 p.s.i.g.

⑤ (Below) Model 0630-P103 Compressor, up to .6 c.f.m. To 25 p.s.i.g. or 24" vac.

⑤

FOR ORIGINAL EQUIPMENT APPLICATIONS ON CONTROLS, INSTRUMENTS, BUSINESS MACHINES, LAB EQUIPMENT

Now — where space is very limited — you can provide moderate vacuum or pressure with one of these two types (3 series) of Gast semi-miniature Air Pumps.

They run entirely without oil. Carbon vanes lubricate themselves, producing a completely oil-free air blast or exhaust. Rotary design is simple, trouble-free and positive in air displacement.

The largest Model 1030 (1 above) delivers up to 1 c.f.m. running open at 3450 r.p.m. Model 0630 (5 below) has identical exterior, delivers up to .6 c.f.m. Smaller type 0330 (2, 3, 4 above) is shown with a choice of motors to suit various pump applications, both a.c. and d.c. With a rotor diameter smaller than a penny, Model 0330 produces up to .67 c.f.m. (open) at 6000 r.p.m.!

These "semi-miniatures" may solve a problem for you — investigate today!

WRITE TODAY FOR BULLETIN M-OVP.

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See Catalog in Sweet's Design File

GAST ROTARY

- AIR MOTORS TO 7 H.P.
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- VACUUM PUMPS TO 28 IN.

"Air may be your answer!"

CIRCLE 134 ON READER SERVICE CARD

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Series "23" "LOCKWELD" double ball race casters. 3"-8"

Series "21" single ball race casters. 2"-6"

Fairbanks "LOCKWELD" Casters are the different casters—the casters without the king-pin — the casters without the major cause of caster failures.

Fairbanks "LOCKWELD" Casters are stocked, sold and recommended by leading distributors in all the principal cities across the nation. Call your distributor today and ask him to show you how the patented "LOCKWELD" Casters will save you maintenance and replacement costs.

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Branches: Boston, Mass.; Chicago, Ill.; New York, N. Y. Pittsburgh, Pa.; Rome, Ga.

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SPRAY ENGINEERING CO., *133 Cambridge St., Burlington, Mass.*

CIRCLE 211 ON READER SERVICE CARD

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Here is a list of special reports still available. You may obtain them by writing Reader Service Dept., PRODUCT ENGINEERING, 330 W 42 St., New York 36. Please enclose remittance with order; we pay postage.

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How to Choose the Right Solder Flux (25¢) .....R 51
Magnesium Finishes (25¢).....R 50
Positive-Displacement Pumps (25¢) .....R 49
Reinforced Plastics (60 p $2)....R 48
Fastening Gears to Shafts.....R 47
Manual for Reliability (32 p 50¢).R 46
Stress Analysis of Combined Loads on Beams (25¢).....R 45
Aluminum Diecastings (25¢).....R 44
The Rare Earth Metals (25¢)....R 43
Hand Lay-up (25¢) .....R 42
Design by Digital Computer (16 p 50¢) .....R 41
Four Bar Linkages (25¢).....R 40
Air Preforming with Matched-metal Dies (25¢) .....R 39

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PITTSBURGH, 22—4 Gateway Center EXpress 1-1314
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FABULOUS "ELECTRONICS HIGHWAY"

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(Advertisement)

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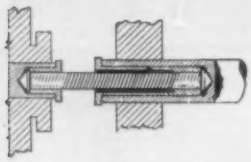


Coupling is used for the transmission of power or control of movement between parts located close together in a piece of equipment. It is not a separate type of flexible shaft but an added application.

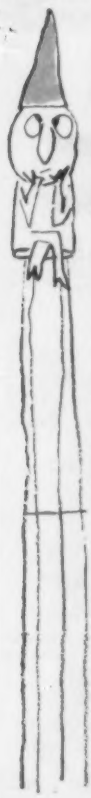
The coupling can be composed of either mono-directional or bi-directional flexible shafting although the latter is generally used due to the added advantage of its ability to rotate both clockwise and counterclockwise. Generally used between two units a few inches apart, coupling transmits power between any two parts regardless of their relative positions.

For example, the diagram above shows an advantage in using small lengths of flexible shafting in a coupling application. Although the drive end and the driven end are not exactly in line, the coupling compensates for the difference in alignment between the two.

Many manufacturers use flexible shaft coupling even where parts may be connected by solid shafts because of the savings realized in the initial and the maintenance cost as well as in time and labor.

For complete information on how flexible shaft couplings may help improve your product design, write F. W. Stewart Corporation, 4311-13. Ravenswood Avenue, Chicago 13, Illinois.

CIRCLE 136 ON READER SERVICE CARD



Have you stopped learning?

A British statesman, it is said, read Gibbons "Decline and Fall of the Roman Empire" while waiting for his wife to dress for dinner.

Once a man feels the urgency to learn, it's remarkable how he finds the time and place to do it.

If he had to spend countless hours seeking out that which would be most useful in his work, the going might be rough. But, happily, this herculean task has already been accomplished by McGraw-Hill specialized magazines that span almost every field and function.

Your very own publication, for instance, that you are reading right now. Read it inquisitively. Read it imaginatively. Pass it along to your fellows, tell them how much they can get out of it, too . . .

Men who read more . . . earn more!

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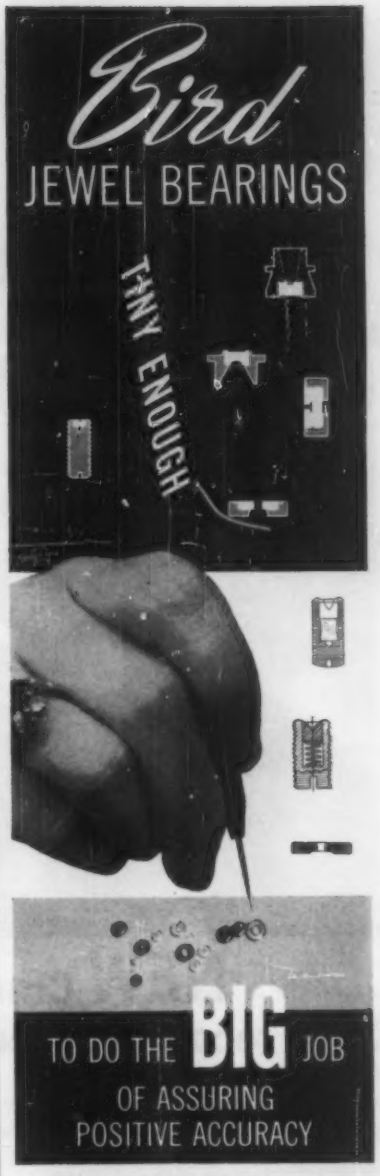

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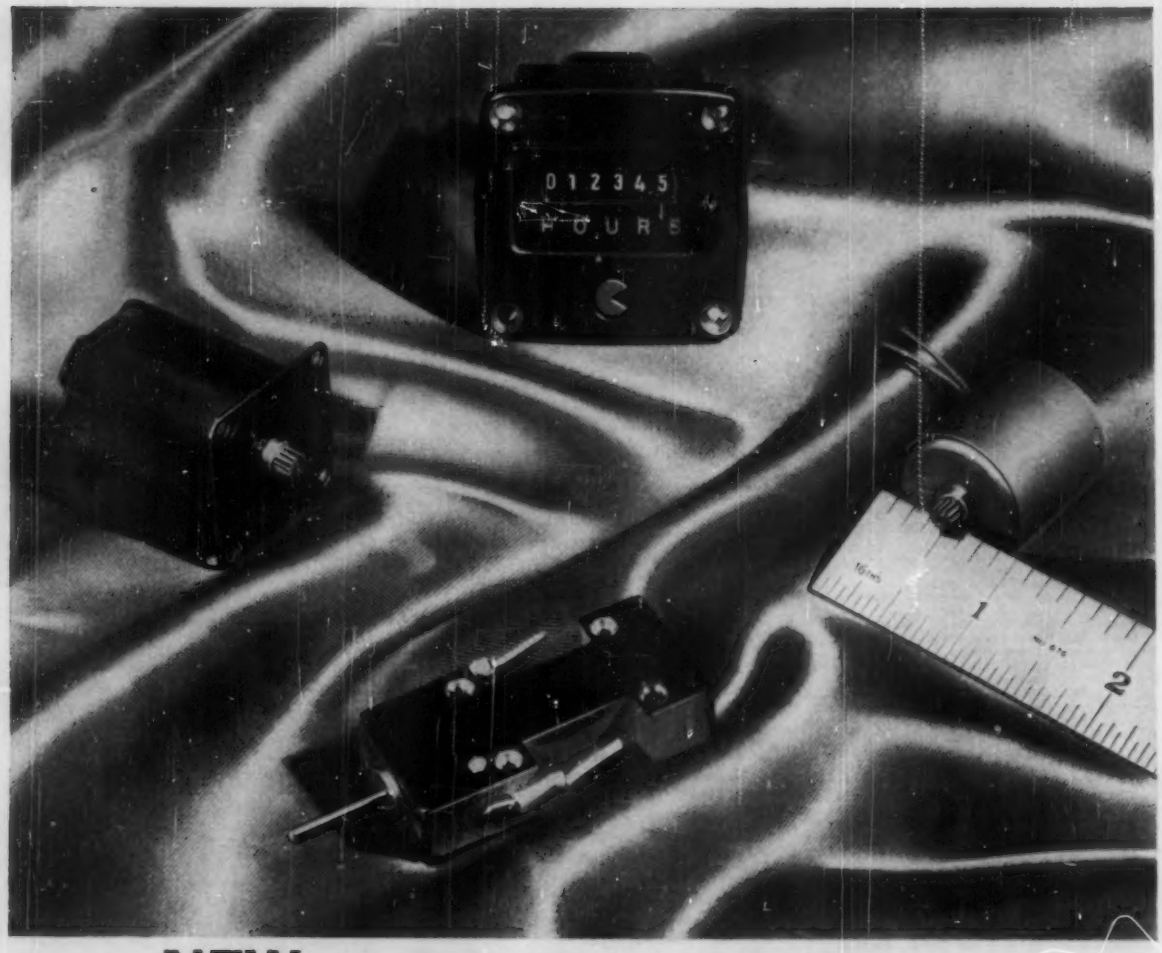

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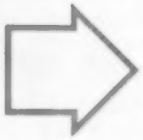

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20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS

P36	P37	P38	P39	P40	P41	P42	P43	P44	P45
P46	P47	P48	P49	P50	P51	P52	P53	P54	P55

*MULTIPLE PRODUCT ADS

Key No.	Specific Product

Please print or type

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Company .....

Street .....

City ..... Zone ..... State .....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS

P36	P37	P38	P39	P40	P41	P42	P43	P44	P45
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Key No.	Specific Product

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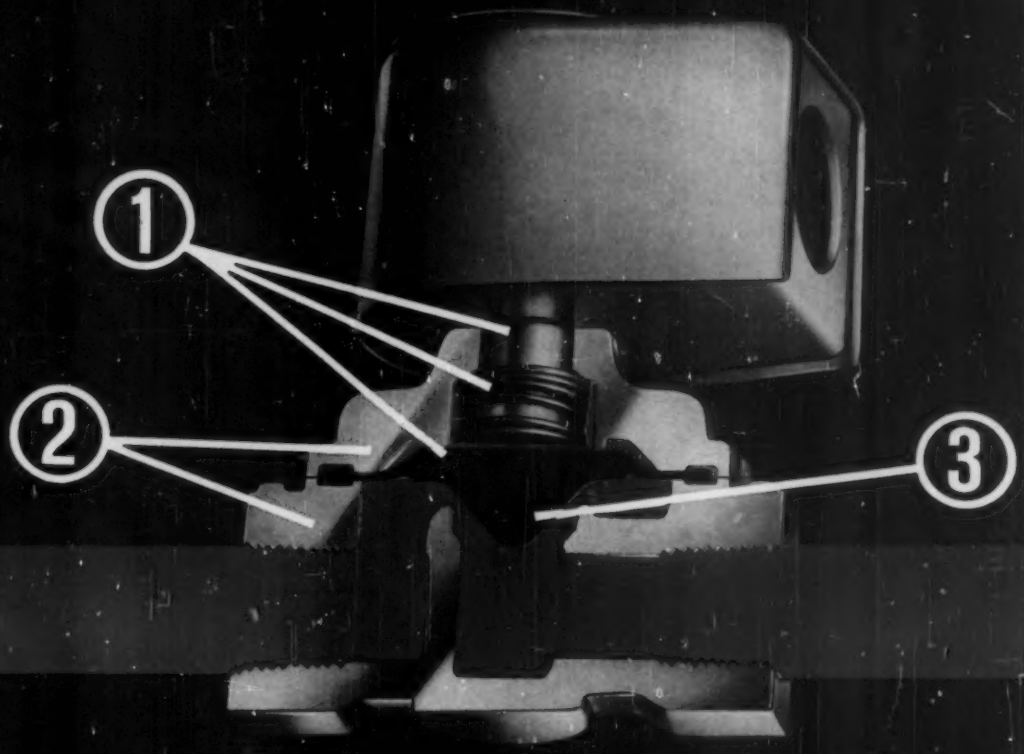

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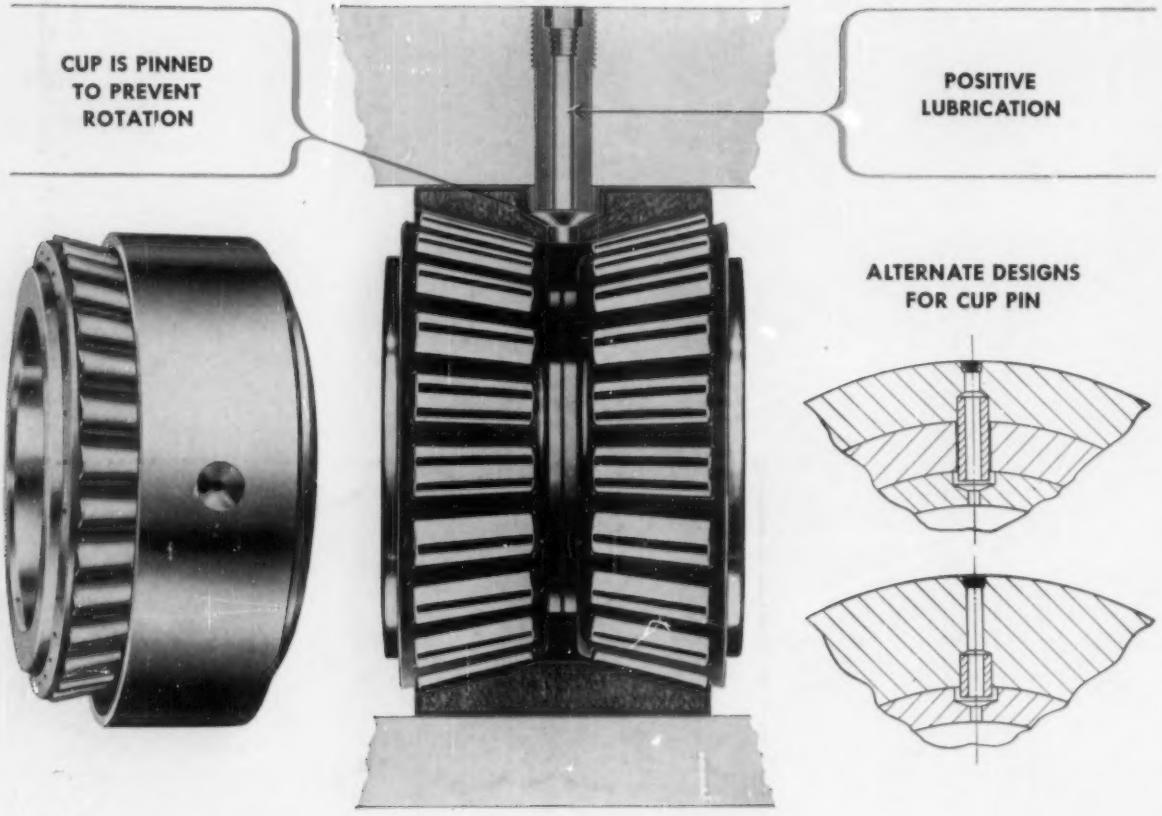

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